SCIENCE

Vol. 87 — Friday, February 25, 1938 — No. 2252

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. — Garrison, N. Y.

Annual Subscription, $6.00 — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

SCIENCE AND SOCIETY

By HAROLD G. MOULTON

PRESIDENT OF THE BROOKINGS INSTITUTION[1]

This series of discussions of "Science and Society" may well begin with some quotations selected with a view to placing the problem before us in broad perspective. The first two statements suggest the vast contributions of science in the evolution of society.

> Science is the soul of the prosperity of nations and the living source of all progress. Undoubtedly the tiring discussions of politics seem to be our guide—empty appearances! What really leads us forward is a few scientific discoveries and their application.[2]

> Science as fundamental knowledge has been the greatest factor in freeing our minds from the preconceptions and superstitions handed down to us through the ages. Our mental attitude has been profoundly modified by our knowledge of the processes of evolution. . . . Knowledge not only helps to set us free, but will lead us on to higher things. . . . The applications of scientific knowledge have made possible a standard of living undreamed of a generation ago. . . . Our greatest hope for future well-being and prosperity lies in further applications of science.[3]

While the authors of the two quotations which follow would not deny the vast rôle which science has played in the evolution of society they nevertheless question

[1] Address of the retiring vice-president and chairman of the section on social and economic sciences of the American Association for the Advancement of Science, given at Indianapolis on December 27, 1937. The address was introductory to a series of five conferences on "Science and Society" to be held under the auspices of the American Association for the Advancement of Science. The first conference was held at the Indianapolis meeting.

[2] Louis Pasteur, quoted in Millikan, "Science and the New Civilization," p. 41.

[3] Irving Langmuir, in address on "Chemical Research," at the dedication of the new building of Mellon Institute, 1937.

the ultimate effects of scientific advancement upon civilization.

The enormous advance gained by the sciences of inanimate matter over those of living things is one of the greatest catastrophes ever suffered by humanity. The environment born of our intelligence and our inventions is adjusted neither to our stature nor to our shape. We are unhappy. We degenerate morally and mentally. The groups and the nations in which industrial civilisation has attained its highest development are precisely those which are becoming weaker. And whose return to barbarism is the most rapid. But they do not realize it. They are without protection against the hostile surroundings that science has built about them.[4]

Humanity stands to-day in a position of unique peril. An unanswered question is written across the future: Is man to be the master of the civilization he has created, or is he to be its victim? Can he control the forces which he has himself let loose? Will this intricate machinery which he has built up and this vast body of knowledge which he has appropriated be the servant of the race, or will it be a Frankenstein monster that will slay its own maker? In brief, has man the capacity to keep up with his own machines?

This is the supreme question before us. All other problems that confront us are merely its corollaries. And the necessity of a right answer is perhaps more immediate than we realize. For science is not standing still. . . . There lies in full view before us a realm of discovery in physical science till now untrodden by mortals even in their dreams.[5]

The fundamental question posed by these statements is whether, as the years pass, science will prove a beneficent power continually advancing the welfare of the people who comprise society, or a social demogorgon. While new technological developments have often been looked upon with apprehension because of the economic readjustments which they bring, it is only within recent years that deep concern has been manifested over the impact of science upon society. The traditional attitude has been that the primary requirement is to encourage in every possible way both scientific discovery and the application of science to productive enterprise. This point of view of course finds expression in the charters of national associations for the advancement of science, as well as in the efforts of universities, industries and governments to promote scientific progress through fostering research. But recently in scientific meetings, as well as in public discussions and private conversations, the question is repeatedly asked: Is not science responsible for many of our existing ills, and does it not, in any case, cast an ominous shadow over the future?

In what concrete ways is science held to be a menace —a threat to the future of civilization? At its door various commentators, reflecting upon the undisciplined progress of the past 100 years, have placed responsibility: for developing an industrial organization of such vast complexity as to baffle human control; for creating an international economic structure in a world of political nationalism; for building implements of warfare which threaten the very extinction of peoples; for so mechanizing work processes as to dull the qualities of human intelligence; for changing the relative rates of population growth in the upper and lower strata of society; for bringing into existence new forms of goods and services in such rapid succession and in such profusion as to make it difficult for slowly changing human beings to assimilate them; for giving us leisure that we do not know how to use; for producing chronic unemployment and the grave social problems which it entails; for building up a capacity for production beyond our powers of consumption; for creating an artificial way of life in place of the old simplicity; and for distorting ethical values and undermining religion and morals.

Meanwhile, the ambitions of science are not being realized; indeed, there is a deep feeling of frustration. Applications of new knowledge and inventions to productive processes are delayed by restrictive business practices and governmental regulations and especially by great economic dislocations which thwart the profit incentive and at the same time diminish the financial resources required for continuing research.

It is this prevailing confusion and uncertainty with respect to issues of transcendent importance which has suggested to the American Association for the Advancement of Science the need of holding at this juncture a series of conferences, or symposia, in which representatives drawn from various sections of its membership may join in a systematic consideration of science and society.

THE NATURE OF OUR PROBLEM

The term *science*, as employed in the foregoing quotations, obviously relates to discoveries in the realm of natural phenomena and their use through the medium of technological developments. However, in the series of discussions which the association is here inaugurating, the problem is to be considered not merely in terms of the impact of the natural sciences upon society. We shall be quite as much interested in the reciprocal effects of economic and political organization upon scientific discoveries and upon the applications of new knowledge to the processes of wealth production. In short, our concern is with the combined and interrelated influence of the development of science and of the evolution of economic, political and social institutions upon economic and social progress.

[4] Alexis Carrel, "Man, the Unknown," (1936), p. 38.

[5] Raymond B. Fosdick, "The Old Savage in the New Civilization," (1928), pp. 21–22.

Moreover, we shall be considering the implications of *science* in a broader setting than natural phenomena merely. The term science is in some ways ambiguous and confusing: to some it merely connotes a field of study—"the natural sciences"; to others it means a particular method of analysis; and again it often suggests a body of exact principles of fixed and unchanging character. What we are really interested in here is the *scientific spirit,* which is an attitude of mind. As William James expressed it: "I have to forge every sentence in the teeth of irreducible and stubborn facts."

The objective, open-minded, scientific outlook need not of course be restricted to consideration of natural phenomena; it may and should pervade all other realms of investigation. Nor is there any single methodology or technique of scientific inquiry. There are as many different methods of observation, experimentation and analysis as there are divisions of science; indeed, within the same field more than one technique may be employed, and even a single research project may require the utilization of a combination of methods. Galileo, Newton, Franklin, Darwin, Pasteur, Edison, Pavlov, Mill and Curie employed widely differing methods of observation and analysis in arriving at their generalizations. They were alike only in the common purpose of deriving their conclusions from facts.

It should also be observed here that the conception of science as a body of exact knowledge, embodying principles and laws of eternal verity, has in recent times undergone profound modification. The human mind, or rather spirit, longs for certainty; and it was the hope that as the proclaimed doctrines of the authoritarian age were overthrown the advance of science would unfold the laws of nature and reveal for our contemplation and satisfaction the ultimate truths of the cosmos. In the eighteenth and nineteenth centuries scientific writers in every field—in economics and law and government as well as in the realm of natural phenomena—sought to systematize and crystallize knowledge in a body of fixed principles.

But it has been found necessary as the years have passed, and especially in the last few decades, to qualify our former generalizations in the light of new knowledge and conceptions and also in the light of organic changes in the phenomena under investigation. This last consideration is of course especially the case in the social fields where institutions and processes have recently been undergoing rapid evolution. Nothing altogether endures; even mathematical analysis has undergone profound modification in the last half century. As summarized by Whitehead:

> The progress of science has now reached a turning point. The stable foundations of physics have broken up. . . . The old foundations of scientific thought are becoming unintelligible. Time, space, matter, material ether, electricity, mechanism, organism, configuration, structure, pattern, function, all require reinterpretation.[6]

A state of flux in scientific thought is disturbing to some minds; to others it only serves to open anew and more widely the avenues of intellectual adventure and to stimulate the quest for yet more knowledge, as well as for greater wisdom in its use. While the present age of disorganization and doubt calls for re-examination of basic tendencies and relationships and a broader orientation of our thinking, it has no place for discouragement with respect to science. On the contrary, the challenge to imaginative and unfettered minds was never so great as now.

Rapid change is commonly viewed with profound concern, even by distinguished students of social trends. We not only fear the unknown road that opens before us, but we distrust the capacities of individuals for adjustment to a changing environment; we envisage the destruction of old ideas with nothing adequate to take their place and we foresee the disintegration of the primary virtues on which our lives have been built.

Perhaps the best corrective to the perennial concern over "ominous current developments" is to be found in historical comparison. Hence I set side by side a 1937 quotation relating to modern developments in the field of locomotion and one written in 1673 pointing out the baleful effects upon humankind of the coming of the stage coach. Due allowance will of course be made for the presumably deliberate effort of the writers in both cases to gain through exaggeration an increased attention to what they regard as developments of serious human import.

> The once erectly striding biped abandons human locomotion and whizzes through the landscape, crouched over wheels and levers worked by his still prehensile hands, and his flat, vestigial feet, no less useful for this purpose than those of his Simian ancestors.[7]

> Travelling in these Coaches can neither prove advantagious to Men's Health or Business: For, what advantage is it to men's Health, to be called out of their Beds into these Coaches, an hour before day in the morning, to be hurried in them from place to place till one hour, two, or three within night; insomuch that after sitting all day in the Summer time stifled with heat, and choked with dust; or the Winter time starving and freezing with the cold, or choked with filthy Fogs, they are often brought into their Inns by Torchlight, when it is too late to sit up to get a Supper; and next morning they are forced into the Coach so early, that they can get no Breakfast. What addition is this to men's Health or Business, to ride all day with strangers, oftimes sick, ancient, diseased Persons or

[6] "Science and the Modern World," p. 24.

[7] Earnest A. Hooton, in address to the American Society of Mechanical Engineers, December, 1937.

Young Children crying. . . . Is it for a Mans Health to travel with tired Jades. . . . .

For passage to London being so easie, Gentlemen come to London oftner than they need, and their Ladies either with them, or having the Conveniences of these Coaches, quickly follow them. And when they are there they must be in the Mode, have all the new Fashions, buy all their Cloaths there and go to Plays, Balls and Treats, where they get such a habit of Jollity, and a love to Gayety and Pleasure, that nothing afterwards in the Countrey will serve them.[8]

All this is presented, I hasten to add, not for the purpose of suggesting that present-day fears are altogether groundless. My purpose is merely to place current problems before us in historical perspective and in a setting which may suggest grounds for hope. In concluding this introductory statement, it may be well to recall that although former civilizations have declined it is not of record that such disintegration was the result of too much science. Perhaps the way forward lies in a great extension of the scientific spirit.

Scientific Foundations of the Modern Social System

The system of free enterprise under which the vast economic expansion of the past 100 years or so has occurred has often been extolled. But there is little realization of the part played by science in laying the foundations of this system. Again, while the influence upon man's productive power of the application of scientific discoveries to industry has repeatedly been emphasized, comparatively little has been said about the reciprocal importance of social institutions in promoting scientific advancement. A brief recapitulation of the mutual interactions of scientific and social developments over the past few centuries may thus prove a useful background against which to project our thinking with respect to the present and the future.

In the Middle Ages, to go no further back, men's thoughts were largely determined by higher authority. They were not supposed to question *why,* but only to *believe.* Similarly, under the economic organization known as the Feudal System men's productive activities were directed from above with the individual possessing virtually no freedom of choice. Even after feudalism disintegrated in the fifteenth and sixteenth centuries, a centralized control of economic life was continued under the city states and the emerging national governments which followed. Even under the so-called mercantilist system of the eighteenth century business enterprise remained so hedged about by governmental controls that little opportunity was afforded for the exercise of individual initiative. It appears clearly to have been the influence of the great scientific discoveries of the seventeenth century which in due course provided the philosophical foundations for the system of free private enterprise.

[8] Excerpt from "The Grand Concern of England," 1673. Quoted in Sir Josiah Stamp, "The Science of Social Adjustment."

The key to the great transition from regulated to free enterprise was found in the conception of *"nature's laws"* with which the physical scientists were concerned. What about the human being? Was he not a part of the natural order of things and if so could he possibly realize his potentialities if his life were circumscribed by man-made restrictions which curbed his free-born spirit? The writings of Blackstone, Rousseau, Adam Smith and others who formulated the principles of the common law, the laws of economics, the principles of government and the science of sociology are permeated with the conception of natural law. And Jefferson, it may also be recalled, prefaced the Declaration of Independence with an all-embracing reference to the separate and equal station to which the laws of nature and of nature's God entitle us. These men, drawing their inspiration from the great scientific discoveries of the preceding century sought to apply the new-found knowledge and conceptions to social organization—to invent legal, economic and political institutions in harmony with the universe of nature. The three remarkable events of the years 1775–76—the application of the steam engine to industry, the publication of Adam Smith's "Wealth of Nations," and the writing of the American Declaration of Independence—were not mere coincidence.

The immediate consequence of the writings of the social philosophers of the eighteenth century was the establishment of the system of free business enterprise which characterized the nineteenth century. First, innumerable laws which restricted the freedom and initiative of the individual were repealed. Second, industry and trade were relieved from a multitude of hampering regulations. Third, national boundaries came largely to be ignored through the removal of barriers and restrictions against the free international movement of trade and currency and against the migration of people from country to country. There was born the conception of a world society, in which men should be free not only to develop their individual capacities to the utmost but also to live in whatever spot on the globe they desired and to conduct their business operations without reference to any national boundaries.

This system of free enterprise not only gave direct encouragement to the application of scientific discoveries to the production of wealth, but the expanding scope of business organization made it possible to utilize such discoveries with great effectiveness. In turn, the growth of wealth provided the means essen-

tial to the systematic conduct of large-scale scientific research. Thus through action and interaction science and social organization have made possible—for good or for ill—the highly productive but complex and baffling civilization of our time.

The Dismal Science

The economic principles that were formulated by early nineteenth century economists were so somber in their implications that economics was long referred to as the dismal science. This phrase did not arise, as many have assumed, out of the difficulty or dreariness inherent in economic analysis; it reflected merely the drab outlook for humankind on a planet characterized by the niggardliness of nature. As a setting for the discussion of the great contributions of science to the processes of wealth production during the course of the last century, it will perhaps be useful to summarize very briefly the fundamental conclusions reached with respect to human progress by the earlier writers on political economy.

These scholars concluded that the economic condition of the masses of the people at any given period and the degree of economic progress that might occur with the passage of time were controlled or limited by three fundamental factors: (1) the land or other resources provided by nature; (2) the accumulation of capital, that is, tools, machinery, factories, etc.; and (3) the labor supply. Two of these factors were regarded, so far as expansion was concerned, as subject to severe limitations, while the third—the labor supply—was subject to a very rapid rate of growth which tended to defeat, so far as standards of living were concerned, whatever gains might come from the improvement in the other factors.

While new agricultural areas might be opened to settlement and new mineral, forest or aquatic resources might be discovered, there were clearly ultimate limits to these resources. Moreover, the fundamentally important land resources were very definitely limited from the point of view of quality. The most fertile areas were in the main those first utilized and, as population grew, resort would have to be had to poorer and poorer land. While improved methods of land utilization might serve to increase productivity, such increase was subject to the law of diminishing returns.

The supply of capital was limited by factors of a different type. In brief, its increase involved a choice between the *immediate* satisfactions that might be realized by devoting all our energy to the production of consumer goods and the larger satisfactions that might *ultimately* be realized if some of our resources were currently devoted to the production of capital goods in order to increase our future productive capacity. The growth of capital thus depended upon the ability and the willingness of individuals to make current sacrifices for the sake of future gains. Inasmuch as the great majority of human beings possessed the most meager standards of living, and were moreover regarded as lacking in foresight, it did not appear likely that capital would be created at a rapid rate. Moreover, if capital should perchance for a time be increased with exceptional rapidity its use in conjunction with limited natural resources would inevitably result in a decrease in its marginal productivity. Hence its interest yield would decline, thus checking the tendency to further accumulation.

The labor supply, on the other hand, was subject to no such limitations. On the contrary, as a result of natural instincts, it tended inevitably to increase out of all proportion to the other factors of production. Hence population growth would necessitate a continuous resorting to poorer resources, thereby tending to reduce living standards to the minimum of subsistence. While war and pestilence might serve at times to improve the balance among the factors of production, there appeared little hope for progressively rising standards of living—unless perchance "prudential restraint" might eventually serve to control the birth rate.

It was the geometric rate of population growth as compared with the arithmetic rate of growth of the other factors which not only gave to the science of economics its awesome appellation, but also foreshadowed a grim future for the human race. Moreover, the conditions of life in China, India and other old civilizations afforded striking illustration of the permanent tendency for population growth to exceed that of other resources; indeed, the very redundancy of the labor supply served as an effective deterrent to technological developments which might economize human labor.

To-day, as every one realizes, the situation is profoundly different from that which was contemplated by the observers of the early nineteenth century. In a large part of the world the standards of living have been enormously increased and the dire results of the laws formulated by our economic forefathers appear somehow to have been avoided. Instead of a conception of all controlling scarcity, we are troubled with conceptions of abundance; indeed, before the eyes of many is the specter of super-abundance. We have, moreover, been utilizing the powers of government to restrict further technological advancement—through fear of the economic and social consequences.

The Scope of These Conferences

The first task in this series of conferences is to make an appraisal of the factors which have been responsible for the great changes which have come in the last century, with particular attention to the rôle of science

in these developments. Hence the series of papers given in this first conference are grouped around the general theme "Fundamental Resources as Affected by Science."

The first two papers are concerned with agricultural and mineral resources. In each case the primary purpose is to show the ways in which the applications of science have served to amplify, increase or otherwise modify or utilize these basic natural resources. Other papers are focussed on the growth of capital, the development of business organization and the utilization of power, which has revolutionized the processes of production during the past century. Finally, we survey the changes that have occurred with respect to the labor factor—indicating the economic significance of changing rates of population growth and the improving utilization of our human resources.

The organization of the five succeeding conferences is still in a tentative state, and it is hoped we may receive many suggestions for improvement. However, in order to provide a basis for suggestions we present herewith a brief statement designed to indicate the character of the conferences which we have in mind.

To the second conference we have given the general title "Science and the Future." Whereas the first conference was concerned mainly with reviewing the developments of science in relation to society over the course of the past century or so, the second conference will be chiefly devoted to indicating what may be expected in the way of future applications of science in the service of society. For this appraisal of the range of potentialities which science holds for the future we must of course look to representatives of such fundamental sciences as physics, chemistry and biology, and also of applied engineering.

As a foundation for this forward look, we shall in the first session take stock of the present. The first paper will deal with "World Standards of Living," with a view to indicating as precisely as possible just how far we have progressed in the direction of "reasonable" or "satisfactory" conditions of life, and the general magnitude of the production problem still before us. Another paper will survey the situation with respect to "World Natural Resources" at the present time. For the second session we plan two major papers to which we have given the titles "Physics and the Future" and "Chemistry and the Future." In each case we should like to have as realistic a picture as it is possible to give in the light of present knowledge of what these sciences hold in store for the future. The third session, devoted to the "Biological Sciences and the Future" would undertake a similar ask. The discussions, however, should not include the direct relationship of biology to the development of man himself, for this aspect of the problem is reserved to the fifth conference. The final session of the present conference we have entitled "The Future Applications of Science," the central purpose being to indicate the character of the engineering and business problems involved in applying the results of scientific knowledge to production.

To the third conference we have given the general title "The Economic System in Relation to Scientific Progress." Inasmuch as the practical benefits of scientific discoveries can be realized only through their applications in industry, an efficiently functioning economic system is obviously of fundamental importance. Traditionally, it has been assumed that the process of applying the results of scientific discoveries to human welfare is more or less automatic. New scientific discoveries lead to inventions of improved instruments of production which in due course are utilized by industry in increasing the efficiency of production. Increasing efficiency simply means producing more with the same effort—in consequence of which standards of living are raised. In fact, however, the process is one of great complexity, having its setting in a structure of pecuniary costs, prices and profits, and distributing its fruits in the form of money income which must be exchanged for the goods and services desired.

The introductory paper, entitled "Free Enterprise and Scientific Development," should reveal the ways in which the modern economic system has promoted the growth of large-scale business organization and stimulated the development of science and its applications to the productive process. It should also explain how the price and profit mechanism is supposed to operate and must operate if the results of scientific discoveries are to be utilized promptly. The second paper should discuss the handicaps and impediments to the successful operation of the existing mechanisms as the economic system has increased in size and complexity. Another paper should be devoted to the significance of the monetary and credit system by means of which modern large-scale business enterprise is conducted. Inasmuch as recurring business depressions periodically retard the applications of science to productive enterprise, there must of course be discussion of the so-called business cycle. It is hoped that a joint consideration of this problem by natural scientists, industrial engineers and economists may shed new light on this baffling phenomenon. A final session in this conference might well be devoted to what may be called "The Scientific Approach in Economics." Scholars working in the field of the social sciences like to believe that they are scientific in their outlook and methodology; but our brethren in the field of the natural sciences not infrequently express skepticism on this point. It seems desirable, therefore, that serious con-

sideration should be given to the methodology employed in economic investigations and to the potential contributions which natural scientists might make to economic analysis.

In the fourth conference we turn from the field of private enterprise to discuss "Government in Relation to Scientific Progress." The introductory paper should survey the changing rôle of government in economic enterprise from the Middle Ages to the present time. It should outline the manifold ways in which government to-day attempts to assist, regulate or participate in economic activities. A second session would undertake a critical appraisal of the patent system, by means of which government seeks to encourage and reward invention. Attention must be given to the bearing both of present laws and of business policies on the utilization of inventions. An underlying concept of democracy is that all its members are entitled to the fruits of new knowledge, which should be permitted and encouraged to flow quickly through the channels of productive enterprise in the service of society. Are there factors and tendencies which impede this process and, if so, by what means may the situation be remedied?

The continuous expansion of the functions of government in recent times has involved a vast increase in public indebtedness in nearly every country in the world. Some government enterprises yield revenues adequate to cover their costs, while others are not self-supporting. Our discussions should include an appraisal of these developments, with the central purpose of determining the growth of tax requirements in relation to the growth of the taxable income of nations. Unbalanced fiscal systems increase the burdens of taxation, lessen the funds available for the advance of science and technology, and also ultimately undermine the stability of both fiscal and monetary systems, which in turn impedes business enterprise and retards economic progress. If we are to continue the forward road to higher standards of living we must obviously preserve the financial and credit foundations.

We must also give consideration to the scientific approach in government. In what ways does our political organization promote and in what ways does it impede the scientific outlook with respect to problems which vitally concern the welfare of the people? What changes in organization and in procedures might be suggested with a view to facilitating the development of the scientific point of view with respect to governmental issues? Similarly, our attention must be given to the future rôle of government in fostering scientific research. Must we, as many apparently believe, henceforth look increasingly to government to provide financial support for, and also to give stimulus and direction to, scientific research? Or, as others apparently believe, must we continue to rely primarily upon endowed institutions and industrial organizations as the best means of preserving freedom and flexibility in the conduct of research? Is there a middle ground or a division of labor with respect to this great problem; and, if so, what are the principles or conditions necessary to effective cooperation? This would seem to be one of the fundamental issues to which this association should give attention if it is to advance science.

Since our ultimate goal is the development of the individuals who compose society, we make "Science and Human Beings" the theme of our final conference —to be held two years from this date. Are the changes in modes of life and in human attitudes which have been, or may be, wrought by scientific discoveries and their applications to productive processes beyond our frail human powers of effective assimilation? What of the alleged advantages accruing as a result of our escape from unremitting toil and the acquisition of leisure in which to study and improve the mind, to contemplate the beauties of nature, to enjoy and profit from broader human associations?

We do not need, or wish, oratorical effusion on this primary issue of contemporary civilization. What is required is a pooling of our scientific resources in studying the effects of science upon human beings. To this end we need the cooperation of the medical scientists, of biologists and geneticists, of psychologists and psychiatrists, of sociologists and philosophers, and also of those who devote their lives directly to the service of individuals through educational institutions, the churches and welfare and character-building and life-adjustment agencies. Our purpose is to take stock of current tendencies by bringing to bear upon them as wide a range of scientific knowledge and human experience as is possible. We express the hope that this conference may be the forerunner of others to be held under the auspices of this association for the purpose of clarifying, and perhaps gradually solving, some of the problems which now confuse—but challenge—our thinking.

OBITUARY

WILLIAM HENRY PICKERING
1858–1938

William H. Pickering was born in Boston on February 15, 1858. After graduating from the Massachusetts Institute of Technology in 1879, he was instructor in physics there until about 1883, when he became engaged in astronomical research at the Harvard Observatory, where his brother, Edward C. Pickering, nearly twelve years his senior, had been appointed director.

One of his first experiments resulted in an excellent photograph of the constellation Orion, obtained by using a dry plate in a small camera attached to the tube of a telescope. The success of this experiment caused him to suggest to his brother the feasibility of a systematic photographic survey of the sky. Thus was started the Harvard collection, now containing about 400,000 stellar photographs.

The lure of astronomical phenomena led him on frequent journeys: for observing total eclipses of the sun, to Colorado in 1878; to Grenada, W. I., in 1886; to California in 1889; to Chile in 1893 and to Georgia in 1900. For comparing earthly craters with those of the moon, he went to Hawaii and to the Azores.

He discovered the great nebula of spiral structure encircling the whole constellation of Orion, and as early as 1899 he suggested the rocking mirror method to determine the velocity of meteors.

When the Boyden fund of $240,000 for establishing an observing station at a high altitude was granted to Harvard Observatory, the first step was to secure the best location. Little was known in those days as to the geographic and meteorological conditions leading to good seeing, and Mr. Pickering was apparently the first astronomer to devise a well-planned scale of seeing. This he did from observations in Colorado and later in Peru. Professor S. I. Bailey had already selected Arequipa, Peru, as the most suitable location for the Boyden station, and thither Mr. Pickering went in 1891 to superintend the construction of the spacious living quarters and housings for the various telescopes.

When the Bruce 24-inch doublet was set up there by Professor Bailey, Professor Pickering planned that a series of photographs of Saturn be taken, as he wished to make an intensive search for a ninth satellite, for which his examination of plates taken with the 13-inch Boyden telescope had been unsuccessful. Soon after the Bruce plates were received in Cambridge, in March, 1899, he discovered a faint object, about magnitude 15.5, which was moving with the planet. This satellite was christened Phoebe after one of Saturn's sisters. As it was found to be impossible to fit into any computed orbit the observed positions of this faint object, Mr. Pickering thought perhaps there might be two satellites of the same magnitude which happened to be near each other at that time. The "improbable idea" then occurred to him that Phoebe might revolve in a retrograde direction. The computation of such an orbit proved to his astonishment that here was a body in the solar system revolving in an opposite direction from all the others then known.

The moon was for many years an object of great interest to Professor Pickering. For the photography of the moon a telescope having an aperture of twelve inches and a focal length of 135 feet was set up at Mandeville on the island of Jamaica where the atmospheric conditions had been found to be extremely favorable to astronomical work. The "Photographic Atlas of the Moon" was published in 1903 and contains eighty plates, made from the Jamaica negatives, forming the most complete study of our satellite then known. His photography and study of the crater Eratosthenes proved to him that marked changes occur in the spots and in the appearance of a system of canals, which he attributed to a low form of vegetation, believing that a "slight local atmosphere and a considerable bulk of water may exist around an active volcanic vent."

Ever since the discovery of Neptune the existence of a trans-Neptunian planet had been a fascinating subject of speculation. Professor Pickering set himself the problem of determining whether such a planet existed, and, if so, to locate it. By graphical processes, he theorized concerning various perturbations, especially those of Uranus by Neptune. As late as 1919, he sent the position for the hypothetical planet to the Mount Wilson Observatory asking them to secure photographs of the region. They did so, but failed to locate the object. When, in 1930, the planet was tracked down on a Flagstaff photograph, these Mount Wilson plates were examined more carefully, and "Pluto" was actually found near Pickering's position, but somewhat fainter than his estimate. Little wonder is it, that when he saw the symbol combining P and L for Pluto he remarked, "That's a good name, Pickering-Lowell."

For many years Professor Pickering was recognized as the leading American observer of Mars. His results were published in forty-four Monthly Reports from 1914 to 1930 in *Popular Astronomy.*

Since 1911 Professor and Mrs. Pickering have lived at Mandeville, Jamaica. Until his retirement in 1925, the Mandeville station was a branch of the Harvard College Observatory. After that it was continued as his private observatory where almost to the end he carried on regular visual observations of the moon and planets. A young student-astronomer who spent several months at Mandeville in the spring of 1936 found him at work on a composite map of Mars from all the drawings of the "Associate Observers of Mars" and keenly interested in such problems as the changing disc forms and markings on Jupiter's Third Satellite, Ganymede.

Professor Pickering died at Mandeville on January 17, 1938. He is survived by his widow, who was Anne Atwood Butts, of Boston, and by their two children, William T. Pickering, of San Marino, California, and Esther, Mrs. Merton S. Harland, of Alberta, Canada.

ANNIE J. CANNON

HARRY WALTER TYLER
1863–1938

DR. HARRY W. TYLER, professor emeritus of the Massachusetts Institute of Technology and formerly general secretary of the American Association of University Professors, died on February 3 in Washington of a heart ailment. Dr. Tyler, who had lived at the Cosmos Club for some months since the death of Mrs. Tyler, had become ill only a few hours before he died. He was head of the department of mathematics at the Massachusetts Institute from 1901 until his retirement in 1930. Since that time he had been living in Washington, serving as general secretary of the American Association of University Professors and as a consultant of the Library of Congress.

Professor Tyler had a long and distinguished career on the faculty of the Massachusetts Institute, having joined the teaching staff at the time of his graduation in the class of 1884 and having had the rank of professor since 1893. In addition to the duties of professor of mathematics, Dr. Tyler has served as registrar of students and for many years as secretary of the faculty. Always a champion of the autonomy of the institute he fearlessly, logically and successfully supported its independence. As chairman of the Walker Memorial Committee he guided the campaign which brought into existence the splendid student center which has served so admirably for a score of years. Under his wise guidance, the department of mathematics became one of the first rank in this country.

For many years he was prominent in the American Association of University Professors, having been a charter member and having served as general secretary from 1916 until 1934. Upon his voluntary retirement in 1934, he was elected vice-president for 1934 and 1935 and editor of the *Bulletin,* the official publication of the association, which he edited until July 1, 1937. He rendered important service to the academic profession on behalf of academic freedom and tenure which will be of lasting benefit to the free spirit in our institutions of higher learning. Just prior to his death, Dr. Tyler had completed important chapters on "Academic Freedom" for the John Dewey Yearbook and for the Social Science Research Council.

When Dr. Tyler moved to Washington, D. C., he made a place for himself in the hearts of the alumni of the institute as he had among his associates in Cambridge. He became president of the Washington Society, and with his delightful sense of humor and winning leadership, his fellow alumni would have no other one for their president until he died.

A native of Ipswich, Massachusetts, Dr. Tyler, after graduating from the Massachusetts Institute of Technology in 1884, studied at the University of Göttingen and in 1889 received the degree of Ph.D. from the University of Erlangen. In 1887, he married Miss Alice I. Brown, of Roxbury, Mass., who preceded him in death by only a few months. X.

RECENT DEATHS AND MEMORIALS

DR. GEORGE ELLERY HALE, honorary director of the Mt. Wilson Observatory of the Carnegie Institution, died on February 21 at the age of sixty-nine years.

DR. JOHN EDGAR COOVER, emeritus professor of psychology at Stanford University, died on February 19 at the age of sixty-five years.

M. CHARLES LALLEMAND, of Paris, retired inspector general of mines of France, member and past president of the Academy of Sciences, Institute of France, died on February 1 in his eighty-first year.

THE death at the age of seventy-three years is announced of Dr. W. W. Vaughan, from 1921 until his retirement in 1931 head master of Rugby Public School. He was a past president of the educational section of the British Association for the Advancement of Science and served on the Consultative Committee of the Board of Education and on the government committee appointed in 1916 under the chairmanship of Sir J. J. Thomson, on the position of natural science in the educational system of Great Britain. He was a member of the council of the British Association and of the Advisory Committee on Education in the Colonies. His death resulted from a fall which occurred during his visit to India as a member of the delegation of the association to the jubilee meeting of the Indian Science Congress Association.

FORMAL dedication of the Thomas A. Edison Memorial took place on February 11, the ninety-first anniversary of his birth. A luncheon was given at the Hotel Astor, New York City, during which a switch was thrown to light the tower which has been erected at Menlo Park, thirty miles away. The tower, which rises 131 feet above the site of the original Edison laboratory, where the incandescent lamp was perfected on October 21, 1879, is the gift of William S. Barstow, president of the Thomas Alva Edison Foundation.

AT the exercises at the annual Alumni Day of the New York University College of Medicine on February 22, a symposium on heart disease was given as a tribute to Dr. John H. Wyckoff, at the time of his death last June dean of the college. Dr. Alfred E. Cohn presented a review of Dr. Wyckoff's contribution to the study of heart disease. Other speakers were Drs. Donal Sheehan, Charles E. Kossmann, Irving Graef, Isaac Seth Hirsch, Arthur C. De Graff, Currier McEwen, William Goldring and Clarence E. de la Chapelle.

AT a meeting on February 12 of the Board of Curators of the University of Missouri it was recom-

mended that the new Chemistry Building on the East Campus be named Schlundt Hall of Chemistry in honor of and in memory of the late Herman Schlundt, instructor and professor of chemistry in the university from 1902 to the time of his death in December, 1937. The resolution reads: "Professor Schlundt's long and distinguished service for the university amply merits such a memorial. His influence on the development of chemistry in the university and of scientific interest throughout the state has been conspicuous. His researches, especially in radioactivity, have notably increased the prestige of the university in educational circles. The inspiration which he gave to students throughout his career was unsurpassed. Moreover, the new Chemistry Building itself was constructed and equipped under his general direction, and its convenience and effectiveness are largely due to his expert advice. We are convinced that the early action of the Board of Curators in naming the building Schlundt Hall, as a memorial to Professor Schlundt, will meet with the enthusiastic approval of faculty and alumni alike."

SCIENTIFIC EVENTS

THE DISCONTINUATION OF THE SOLAR OBSERVATORY STATION OF THE SMITHSONIAN INSTITUTION

THE Smithsonian Institution has closed its solar observatory station on the summit of Mount St. Katherine in the Sinai Peninsula, which was selected as the highest, driest spot available for human occupancy in the Eastern hemisphere by Dr. Charles G. Abbot, secretary of the Smithsonian Institution, after the advantages of numerous sites had been considered. The last observers, Mr. and Mrs. Alfred F. Moore and Alfred G. Froiland, have now returned to the United States.

The station was set up to measure daily variations in the heat output of the sun which are believed to have significant although as yet not entirely predictable effects on the earth's weather. Observations were taken every clear day and data assembled which are now being studied.

The Sinai Peninsula station was established after a similar observatory in South Africa had proved unsuitable, and it formed one of a chain of three engaged in similar measurements. The other two are in the Western Hemisphere, and there was always the hope that weather in the Eastern Hemisphere would yield good observing days when it was unfavorable in the west. In order to function properly a station had to be in a sparsely populated land where there would be a minimum of dust in the air and in a country with a minimum of cloudiness. The mountain peak upon which the observatory was built is 8,600 feet high.

The decision to abandon the observatory was based in part on the difficulty of living conditions during the winter when, as was the case last year, the mountain sides were covered with snow and ice a good deal of the time. The practice was to take up supplies on camelback. Camels can not, or will not, go through snow. Consequently everything had to be carried up on the backs of the Bedouins. A great deal of the fundamental data for which the station was established had already been obtained. This had shown conclusively that the same solar changes found in the Western Hemisphere were observed also in the Eastern, and at some times of the year Mount St. Katherine had better observing weather than the western stations. Eventually the station may be reopened. By agreement with the monastery the furnishings have been stored, and the buildings will stand.

THE NEW SCHOOL OF CHEMICAL ENGINEERING AT CORNELL UNIVERSITY

THE establishment of a School of Chemical Engineering as the fourth constituent unit of the College of Engineering at Cornell University has been announced. Dr. F. H. Rhodes, since 1920 professor of chemistry and chemical engineering, was named director of the new school, effective on July 1.

The curriculum will consist of a five-year course leading to the new degree of bachelor of chemical engineering. The facilities of the modern laboratory, made possible by a gift of $1,500,000 to the university by the late George F. Baker, will be coordinated with those of the College of Engineering to train men, not only in chemistry but also for the design, development and operation of actual producing units in chemical plants.

The new school is the outgrowth of a series of courses given in the past twenty-five years, during which there has been an increasing demand for chemists on the part of industry. In 1930 a five-year course in chemical engineering was started and administered jointly by the department of chemistry and the college of engineering. The enrolment in the course has grown so rapidly that while three seniors took the chemical engineering degree in 1932, this year there will be fourteen, and the total number of men registered in all five undergraduate classes is one hundred and fifty-eight. Graduates are accepted by industry as having the equivalent of a master's degree from other universities, and all but one of the Cornell graduates now hold responsible positions in the chemical industry. Cornell's chemical engineering curriculum is approved

by the Engineering Council for Professional Development and by the American Institute of Chemical Engineers.

Professor Rhodes, the first director, received the degree of Ph.D. from Cornell University in 1914. After several years spent in teaching at the University of Montana and Cornell University, he was research chemist and chemical engineer and director of research of the chemical department of the Barrett Company. He also acted as consultant for the Anaconda Copper Company, the Atlantic Tar and Chemical Company and other industrial concerns. He designed the refined products section of the main tar refinery of the U. S. Steel Corporation at Clairton, Pa. Since 1920 he has been professor of chemistry and chemical engineering at Cornell and has been chairman of the committee supervising the curriculum in chemical engineering since its establishment.

AWARD OF THE LAMME MEDAL OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The 1937 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Dr. Robert E. Doherty, president of the Carnegie Institute of Technology, Pittsburgh, Pa., "for his extension of the theory of alternating current machinery, his skill in introducing that theory into practice and his encouragement of young men to aspire to excellence in this field." The medal and certificate will be presented to him at the annual summer convention of the institute, which is to be held in Washington, D. C., from June 20 to 24.

The Lamme Medal was founded as a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company, who died on July 8, 1924, to provide for the award by the institute of a gold medal (together with a bronze replica thereof) annually to a member of the American Institute of Electrical Engineers, "who has shown meritorious achievement in the development of electrical apparatus or machinery" and for the award of two such medals in some years if the accumulation from the funds warrants. A committee composed of nine members of the institute awards the medal. Mr. Lamme made similar bequests to the Society for the Promotion of Engineering Education and to the Ohio State University.

Dr. Doherty was born in Illinois in 1885. He completed his secondary education at the academy of the University of Illinois, and later entered the university, from which he received the bachelor of science degree in 1908. Before he entered the University of Illinois he served for two years as a telegraph operator with the Baltimore and Ohio Railroad. After graduation he was employed as a student engineer by the General Electric Company and was later appointed designing engineer. In 1923 he was appointed consulting engineer for the General Electric Company, and after two years was selected to organize the advanced course in engineering offered by the company. He was also given the responsibility for educational work among the young college graduates that were employed and trained by the firm. In 1931 he was appointed professor of electrical engineering at Yale University, becoming head of the School of Engineering in 1933. Since becoming president of the Carnegie Institute in 1936 he has worked with his associates in reorganizing the curriculum of the College of Engineering.

Dr. Doherty has taken an active part in the educational programs of the professional societies. He was chairman of the committee on education of the American Institute of Electrical Engineers, 1931–33, and has served as a member of several of its committees. In 1934 he was appointed chairman of a committee of the Society for the Promotion of Engineering Education for studying objectives and length of curriculum in engineering colleges.

AWARD OF THE WILLARD GIBBS MEDAL

Dr. Robert R. Williams, of New York, chemical director of the Bell Telephone Laboratories, has been awarded the Willard Gibbs Medal of the Chicago Section of the American Chemical Society, one of the highest scientific honors bestowed in the United States, for "outstanding work in connection with the study and isolation of the beri-beri vitamin." Dr. Williams announced the discovery of the chemical structure of vitamin B_1, the antineuritic vitamin now called thiamin, in January, 1935. He characterized the achievement as a "preeminently cooperative enterprise" climaxing "nearly forty years of effort by scores of workers in many lands." He himself had sought isolation of the vitamin for twenty-five years, having begun his experiments in the Philippines in 1910.

By synthesizing the beriberi vitamin, Dr. Williams made it available to research workers for the first time. Patents concerned with the process of manufacture of synthetic vitamin B_1 have been assigned to the Research Corporation, New York. Under license from this corporation, the vitamin is being produced commercially on a substantial scale and is being distributed by many of the prominent drug firms of the country. The Research Corporation is a non-profit organization dedicated to the management of patented processes and utilizes the proceeds for the support of scientific research.

Dr. Williams was born in Nellore, India, of American parents, on February 16, 1886. He was a student at Ottawa University, Kansas, and at the University of Chicago, from which he received the bachelor of

science degree in 1907 and the master of science degree in 1908. Ottawa University conferred the degree of doctor of science upon him in 1935. From 1909 to 1915 he was chief chemist of the Philippine Bureau of Science, spending the year 1911–12 in postgraduate work at the University of Chicago.

He was for three years with the U. S. Bureau of Chemistry in Washington, D. C. In 1918 he was engaged in the Chemical Warfare Service and Air Service research in Washington; he was associated with the Melco Chemical Company, Bayonne, N. J., in 1919, and later joined the staff of the Western Electric Company. He was named chemical director of the Bell Telephone Laboratories in 1925. In this year he became research associate at Teachers College, Columbia University, where he has carried on much of his investigation. He is also research associate of the Carnegie Institution of Washington.

The announcement of the Chicago section points out that "there is perhaps no more outstanding example of the broad attitude of some of the great corporations toward fundamental research than the brilliant synthesis of the beriberi vitamin by the chemical director of the Bell Telephone Laboratories."

Four laboratories contributed personnel or facilities to the basic research leading to the synthesis of the beriberi vitamin, while the depression beginning in 1929 afforded the investigators at the Bell Telephone Laboratories additional week-end leisure for work. Funds were granted by the Carnegie Corporation.

The Willard Gibbs Medal, founded by William A. Converse in 1911, was named for Josiah Willard Gibbs, from 1871 to 1903 professor of mathematical physics at Yale University, whose discoveries of the phase rule and other thermodynamical laws are the bases of modern physical chemistry.

SCIENTIFIC NOTES AND NEWS

DR. LEONARD CARMICHAEL, dean of the Faculty of Arts and Science and chairman of the department of psychology at the University of Rochester, previously professor of psychology at Brown University, has been elected the seventh president of Tufts College, from which he graduated in 1921.

DR. FREDERICK B. MUMFORD, for thirty-three years dean of the College of Agriculture of the University of Missouri, has presented his resignation to take effect next September. He will be succeeded by Merritt F. Miller, who joined the faculty in 1904 and became assistant dean in 1929. Dr. Mumford's brother, Dr. Herbert W. Mumford, is dean of the College of Agriculture of the University of Illinois.

A MEETING in honor of Dr. Charles E. Coates, who recently retired as dean of the College of Pure and Applied Science and head of the department of chemistry of the Louisiana State University, was held by the Louisiana section of the American Chemical Society at Tulane University on January 18. As a tribute to Dr. Coates the meeting was designated the "Charles E. Coates meeting."

THE Dallas Agricultural Club of the Texas Agricultural Experiment Station gave a dinner on February 21 in honor of A. B. Conner, director of the station. The program included tributes to Mr. Conner as follows: "What Director Conner has Contributed to Texas Agriculture," by Victor H. Schoffelmayer, agricultural editor of *The Dallas News;* "Contributions of Director Conner to National Agriculture," by Dr. C. T. Dowell, director of the Louisiana Experiment Station; "Conner, Our Chief," by R. E. Dickson, superintendent of the Spur Experiment Station.

AMONG the honorary degrees conferred at the midwinter commencement of Temple University, Philadelphia, was the degree of doctor of science on Dr. J. Leon Lascoff, president-elect of the American Pharmaceutical Association. The doctorate of laws was conferred on Henry Butler Allen, director of the Franklin Institute.

THE College of Charleston, South Carolina, will confer at the end of May the degree of doctor of laws on Dr. Harry Stoll Mustard, professor of preventive medicine at New York University.

IN the issue of SCIENCE for January 28 it was stated that the degrees conferred on the occasion of the installation of Dr. Harris as president of Tulane University included the degree of doctor of humane letters on Dr. Walter Smith Leathers, dean of the School of Medicine of Vanderbilt University, and on Dr. Alphonse Mary Schwitalla, S.J., dean of the School of Medicine of St. Louis University. The degree conferred was that of doctor of laws.

THE Anthony F. Lucas gold medal for distinguished achievement in improving the practice of finding and producing petroleum was presented to Henry L. Doherty, president of the Cities Service Company, at the annual dinner of the American Institute of Mining and Metallurgical Engineers on February 16. Others who received awards from the institute were Thomas S. Washburn and John Hunter Nead, who won the Robert Woolston Hunt prize of $250 for a paper presented to the institute last year; Roy A. Lindgren, who received the J. E. Johnson, Jr., award for his paper on performance and selection of refractories for blast-furnace linings, and Hal W. Harding, who

received the James Douglas medal for distinguished achievement in non-ferrous metallurgy.

The first Marconi Memorial Gold Medal for Valor established by the Veteran Wireless Operators Association was presented on February 11 at the annual dinner to Lieutenant Carl O. Petersen, U.S.N.R., for his work in connection with radio communication from an airplane during an exploration flight over the Antarctic Continent with Rear Admiral Richard E. Byrd on January 3, 1934. David Sarnoff, president of the Radio Corporation of America, a life member of the association, made the presentation.

Awards of the British Institution of Mechanical Engineers with the names of the recipients and the titles of the papers for which the award was given are as follows: the Thomas Hawksley Gold Medal to A. P. M. Fleming, "Training of Apprentices for Craftsmanship"; the Thomas Hawksley Premium to Major C. C. B. Morris, "The Organization and Mechanical Appliances of the London Fire Brigade"; the Thomas Lowe Gray Prize to R. F. Davis, "The Mechanics of Flame and Air Jets"; the T. Bernard Hall Prizes to H. Wright Baker, "Piston Temperatures in a Sleeve Valve Oil Engine"; to David Clayton and Christopher Jakeman, "The Measurement of Attitude and Eccentricity in Complete Clearance Clearings"; and the Starley Premium to R. A. Railton, "Racing Motor Car Design."

Jay N. Darling, formerly chief of the U. S. Biological Survey, was reelected president of the General Wild Life Federation at the closing session on February 17 of the National American Wild Life Conference. Other officers elected were: *Treasurer,* C. F. Delabarre, of Blacksburg, Va.; *Vice-presidents,* David A. Aylward, of Cambridge, Mass.; William L. Finley, of Portland, Ore., and Dr. Walter B. Jones, of the University of Alabama. At this meeting the name of the organization was changed to the National Wild Life Federation.

The annual meeting of the Branner Geological Club of Southern California was held at the California Institute of Technology on January 14. Short papers were read at the afternoon session by U. S. Grant, IV, J. C. Hazzard and F. P. Shepard. After the annual dinner John H. Maxson addressed the society on "Modern and Ancient Asia Minor." Newly elected officers are: *President,* Dr. Ian Campbell; *Vice-president,* William Geise; *Secretary,* William C. Putnam. Retiring officers are: *President,* A. I. Gregerson; *Vice-president,* Dr. Ian Campbell; *Secretary,* Robert W. Webb. The membership of the Branner Club consists of professional and university geologists residing in Southern California. Dinner meetings are held monthly throughout the academic year. Visiting geologists are urged to communicate with the secretary in order that they be notified of meeting dates.

Dr. Harold P. Morris has resigned as associate biochemist in the Division of Pharmacology of the Food and Drug Administration of the U. S. Department of Agriculture, to become chemist in the Division of Pharmacology of the National Institute of Health.

Dr. John B. Saunders, associate professor of anatomy at the Medical School of the University of California, has been made the editor for medicine on the magazine *Isis,* the quarterly organ of the International Society of the History of Science.

Professor Charles E. Rush, associate librarian of Yale University, announces that with the assistance of a subvention for one year from the Carnegie Corporation of New York, the American Library Association has founded *The Journal of Documentary Reproduction,* a quarterly review of the application of photography and allied techniques to library, museum and archival service.

Dr. Charles F. Brooks, professor of meteorology and director of the Blue Hill Observatory at Harvard University, has been elected president of the Mount Washington Observatory Corporation, a new scientific organization of 400 members which conducts the Mount Washington Observatory and publishes occasional news bulletins. The observatory was established in 1932 and is financed by the Blue Hill Meteorological Observatory of Harvard University. It is equipped with instruments and apparatus furnished by Blue Hill, the U. S. Weather Bureau, the Massachusetts Institute of Technology, the Eppley Laboratory, Inc., and the General Radio Company, all of which share in the program and results.

Dr. Gustav Egloff, Universal Oil Products Company, Chicago, has been appointed chairman of the Committee on Science and Technology for the tenth International Petroleum Congress and Exposition, which will be held in Tulsa, Okla., from May 14 to 21.

Dr. William T. Penfound, head of the department of botany at Tulane University, has leave of absence for the second semester, during which he plans to study soil chemistry at the College of Agriculture of Rutgers University.

Dr. Frederik Nilsson, who is in charge of plant breeding in Sweden and head of the branch station at Svalof, is visiting the United States.

The Adolph Lomb Memorial Lecture of the Optical Society of America will be delivered on February 25 by Professor Harlow Shapley, director of the Harvard College Observatory, at the annual meeting of the society. This lecture is open to the public. His

subject will be "The Debt of the World to Optical Science."

DR. E. RABINOWITCH, of University College, University of London, will give the John Howard Appleton Lecture of Brown University for 1937–38 on February 28 on "The Photochemistry of Chlorophyll and the Problem of Photosynthesis."

DR. HARALD U. SVERDRUP, director of the Scripps Institution of Oceanography, La Jolla, on February 9 addressed the California Chapter of Sigma Xi on "The Current Systems of the Oceans."

DR. VICTOR HEISER, of the Rockefeller Foundation, spoke on February 14 at Duke University on the public health work done in tropical regions by American physicians. On January 31, Dr. E. G. Crabtree, of the Harvard Medical School, gave a lecture on the "Fluid Balance in the Puerperium."

DR. WILLIAM DE B. MACNIDER, of the University of North Carolina, delivered on February 10 the Brown-Sequard lecture of the Medical College of Virginia, Richmond, on the general subject of acquired cellular resistance.

DR. MAURICE E. BINET, a member of the French Academy of Medicine, president of the Society of Medical Science of Vichy, France, who is making a tour of the United States, recently delivered an address on "Hepatic Insufficiency in the Course of Chronic Colitis" at the Hahnemann Medical College, Philadelphia. Following the lecture the honorary degree of doctor of laws was conferred on him by the college.

DR. F. R. MOULTON, permanent secretary of the American Association for the Advancement of Science, was the principal speaker at the fourteenth annual science luncheon, which was held on February 19 in New York City. Associate Superintendent William E. Grady was toastmaster. The luncheon was sponsored by the Science Council, the Chemistry Teachers Club of New York, the General Science Teachers Association, the New York Association of Biology Teachers, the Physics Club of New York, the Physiographers and Geographers Club and the Association of Laboratory Assistants. An exhibit of recent developments in apparatus and teaching technics was on display.

THE third International Cancer Congress under the auspices of the International Union against Cancer will be held in the United States, from September 11 to 16, 1939, at the Haddon Hall Hotel, Atlantic City, N. J. The president of the congress is Professor Francis Carter Wood, director of the Institute of Cancer Research of Columbia University, New York City; Dr. Donald S. Childs, of Syracuse, N. Y., is the secretary-treasurer, and Dr. A. L. Loomis Bell, of Long Island College Hospital, Brooklyn, N. Y., is in charge of transportation and exhibits. The proposed sections are as follows: General research; biophysics; genetics; general pathology of cancer; surgery of cancer; radiological diagnosis of cancer; radiotherapy of cancer; statistics; education. Further details concerning section chairmen, committees and other data will be announced later. The membership fee will be $15. All inquiries should be addressed to the Institute of Cancer Research, 1145 Amsterdam Avenue, New York, N. Y.

BY the will of the late Edward Bayard Halsted, retired stock broker, Johns Hopkins University and Duke University, Durham, N. C., share equally in the residuary estate of undetermined value, which is believed to be in excess of $500,000. The income from the bequest to Johns Hopkins is to be used "for research work for the advancement of knowledge as to the nature, causes, means of prevention and cure of such maladies as may in the opinion of the governing body be in need of further study and investigation." The fund is to be known as the "E. Bayard Halsted Fund for Medical Research." The university also receives $200,000 on the termination of two trusts. The bequest to Duke University is for the establishment of four scholarships in medicine, science, journalism and history, each for $60,000. Duke also receives $75,000 on the termination of a trust.

MRS. MARION E. STERN, daughter of Julius Rosenwald, has given $75,000 to the University of Chicago. Mrs. Stern reserved the right to specify the educational uses to which the money may be put and has approved the expenditure of $5,000 in scholarships to needy and deserving students.

A FOUNDATION for the furthering of scientific research has been established at Stockholm by Dr. and Mrs. Axel L. Wennergren, with an endowment of a million dollars. Dr. Wennergren is president of the Electrolux Company.

DISCUSSION

FALLING CHIMNEYS

IN the issue of SCIENCE (No. 2176, Vol. 84), published on September 11, 1936, there appeared an article entitled "Concerning Falling Chimneys," which seems to be, in part, in error. The author says:

A simple analysis shows that, since all points of the

chimney are moving with angular acceleration along the arcs of circles prior to the break, the center of percussion of the chimney is the point which has the natural acceleration of a particle moving under gravity along the same path. All parts of the chimney below its center of percussion are retarded; all parts above move with acceleration greater than they would have if constrained to move along the same paths under gravity alone. Hence there is an inertial reaction of the upper portion of the chimney which is opposite to the direction of motion, and the top lags behind. Breaks, if they occur at all, appear first above the center of percussion.

The last assertion about the location of breaks when they occur is obviously not true in the case of the falling chimney shown in the accompanying picture taken from the *Philadelphia Record* of October 8, 1937, since the center of percussion is always above the center of gravity. It is not far wrong to consider that a tall chimney acts like a rod. For a thin rod of height h, turning freely about a point at its lower end, the center of percussion is $2/3\ h$ from the bottom. In the idealized case of a rod, turning freely about its lower end on a fixed pivot, the angular acceleration is $a = 3g \sin\theta/2h$ when the rod is inclined at an angle θ to the vertical. For a particle sliding down a smooth, fixed, vertical circle of radius r, the linear acceleration is ra. When the radius to the particle makes an angle θ to the vertical this acceleration is also $g \sin\theta$; hence when $r = 2/3\ h$ the two angular accelerations are equal. So the author's statement about the location of the point that has the natural acceleration of a particle moving under gravity is correct. However, the implication that the effect of inertial reaction is greatest at this point or above it is incorrect.

If we consider a section of the rod lying above a point X (see Fig. 1), at distance x from the lower end

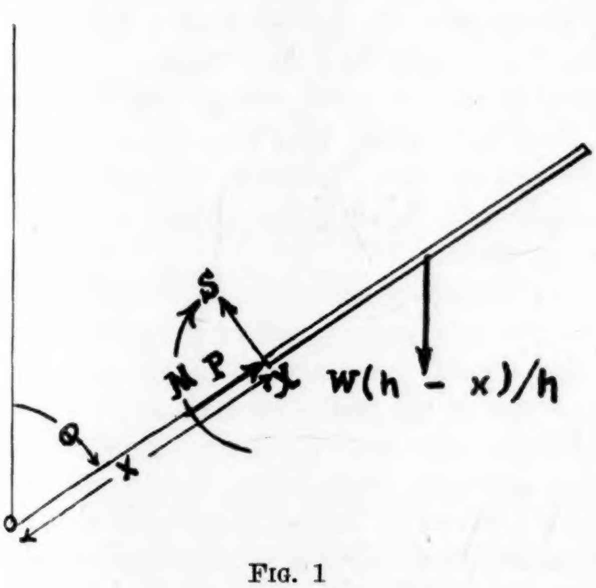


FIG. 1

of the rotating rod, it is seen to be acted upon at X by a moment or torque M, a shear S and a compression P, all arising from the action of the section below X. It is, also, acted upon by its weight at its center of gravity $\frac{1}{2}(x+h)$ distant from the bottom. If the rod breaks because of the motion, the break may be caused by shear, by moment or by a combination of the two. If caused by shear alone it is most likely to occur where the shear is greatest; if caused by moment alone it is most likely to occur where the moment is greatest. A brick chimney will not stand much shear, but brickwork is not assumed to be able to stand any moment, since moment involves tension. Brick and mortar are very easily pulled apart.

From the equations of motion for the part of the rod above X we find for the shear S,

$$S = W \sin\theta\ (h-x)\ (h-3x)/4h^2 = W \sin\theta\ (h^2-4hx+3x^2)/4h^2,$$

in which W is the weight of the rod. It is seen that the shear is zero for $x = h$ and for $x = 1/3\ h$; that is, at the upper end and one third the length from the bottom. The shear is a mathematical maximum where $x = 2/3\ h$; that is, at the center of percussion. But at the bottom it is three times as great as at this point. If the chimney should break from shear it is most likely to occur near the bottom. The picture from the newspaper indicates that this has occurred in the case of the chimney at Springfield, Delaware Co., Pa.

The equations of motion for the part above X, also, give for the moment M,

$$M = Wx\ (h-x)^2 \sin\theta/4h^2 = W(h^2x - 2hx^2 + x^3) \sin\theta/4h^2.$$

It is seen that M is zero for $x = 0$ and for $x = h$; that is, the bending moment is zero at both ends of the rod. The moment is a maximum for $x = 1/3\ h$; that is, at one third the length from the bottom, the moment is greatest. If the chimney breaks from moment alone the break is most likely to occur about one third the way from the bottom to the top. It would seem that the chimney shown in the picture is breaking, at the upper break, from moment largely, which is what one expects in a brick chimney.

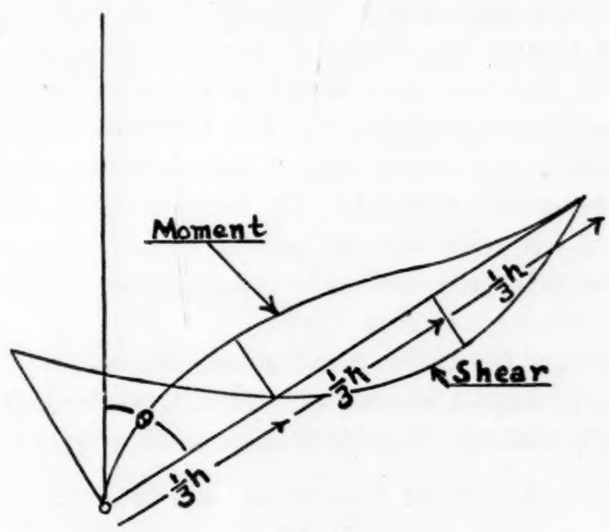


FIG. 2

Fig. 2 shows how the moment and shear vary at points along the length of the rod. The moment causes compression on the upper side of the rod and tension on the lower side. We would expect a crack caused by moment to run from the lower side towards the upper side. This state is seen in the picture.

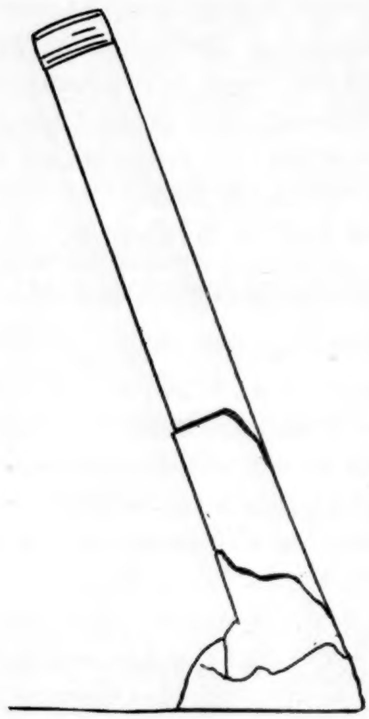


FIG. 3

None of the theories of rupture assume that rupture is caused by shear or moment independently. It would seem that the contention that rupture, if it occurs at all, will happen at or above the center of percussion is unfounded.

JOSEPH B. REYNOLDS

LEHIGH UNIVERSITY

CRASPEDACUSTA NEAR ALBANY, NEW YORK

SOME years ago the pages of SCIENCE carried frequent mention of the occurrence of the medusae of the fresh-water coelenterate, *Craspedacusta sowerbii*. One of the authors, Dr. Waldo L. Schmitt,[1] expressed the opinion that this form would be found to be "more common and widely distributed in the fresh waters of the eastern and eastern central United States, at least, than heretofore believed." Dr. Schmitt's prognostication of ten years ago has proved to be correct, and this beautiful jelly-fish has been recorded rather widely from Oklahoma to New York.

Although the known distribution includes New York State, perhaps a specific note of its local occurrence will augment the available detailed locality records.

[1] Waldo L. Schmitt, SCIENCE, 66: 591–593, 1927.

On August 16, 1937, Mr. C. L. Harpham, of Loudonville, a village three miles north of Albany, N. Y., telephoned me that he believed jelly-fish inhabited the fish pool on his lawn and invited me to inspect it. He had observed these unusual forms in the pool earlier this season, but had not suspected their identity until his attention was drawn to a newspaper account relating the recent acquisition of a number of fresh-water medusae by the New York Aquarium.

That evening I examined the water in the pool and found the jelly-fish as Mr. Harpham had described. The medusae intermittently swam freely near the surface, then sank out of sight. It seemed, however, that the animals spent more time in the depths than at the surface. A stream of water from a garden hose directed into the pool caused the medusae to rise to the surface in numbers, but they soon disappeared below.

About fifty of the medusae were collected, after which their apparent prevalence in the pool seemed to have been in no wise diminished. Upon subsequent laboratory examination of the preserved specimens they were definitely determined as *Craspedacusta sowerbii* (Lankester).

The live medusae which I collected in jars of water from the pool along with scrapings from its sides and a few plant stems, lived for only a little more than twenty-four hours in the containers. While alive they moved about freely and appeared to feed on the minute organisms in the lumps of algal growth. Microscopic examination of the gonads indicated that the contents had been discharged before we captured the medusae.

The rock-lined fish pool carrying the jelly-fish occupies the center of a flower garden near one end of the Harpham residence, which is situated on a high hill in the outskirts of Loudonville village. It is approximately 9½ feet long, 6½ feet wide and 2½ feet deep, while its margins rise only an inch or two above the surrounding closely cut grass. Water in the pool is supplied in part from the village standpipe and in part from rains which have been more than usually copious this summer. However, the elevation of the pool is such as to preclude the entrance of flood water from any source.

A small clump of narrow-leaved cat-tail (*Typha*), arrow-arum (*Peltandra*), yellow pond lily (*Nymphaea*) and several other aquatic plants were growing in the water of the pool. Its rock sides carried fine debris intermingled with a rich algal growth in which, upon microscopic examination, protozoans, rotifers and round worms of various types were found to be the dominant forms of animal life. Several well-kept goldfish also inhabited the water.

During past winters some of the plants were re-

moved, but the pool was only partially drained. The water has not been entirely withdrawn or the pool thoroughly cleaned since 1929. Apparently the most likely source of introduction of *Craspedacusta* to the pool was in the summer of 1936, when Mr. Harpham, Jr., emptied into it about a quart of water containing a large number of anuran amphibian eggs. This material was obtained from a nearby pond.

DAYTON STONER

NEW YORK STATE MUSEUM,
ALBANY, N. Y.

POST-GLACIAL CONSEQUENT STREAMS IN MAINE

IN August, 1936, the writer came upon a gorge on the Merriland River one and three-quarter miles from tide-water, cut about twenty feet through slate. If the till and gravel overlying the slate are added, the cut must be at least thirty feet deep.

The mouth of the Merriland River is located in the northern part of the Town of Wells, near Elms, in southern Maine. The river is nine miles long and from its source runs in an easterly direction for five and one half miles, controlled entirely by the Newington Moraine, then, where the Newington Moraine is very low, bends in a southeasterly direction to the sea. It is a very small stream, and during the summer months the flow is reduced to almost nothing. Only during the seasons of melting snows or heavy rainfall can the stream be dignified by the name of "river."

On the Kennebunk topographic sheet of the U. S. Geological Survey there are eight major streams that reach the sea. Two of these, the Mousam and Kennebunk Rivers, are larger than the other six and may be somewhat older. The writer observed that the Merriland River rises close to the two-hundred-foot contour, with about a mile of headward cutting beyond this. It was then noted that thirty-four streams and branches of streams on the Kennebunk sheet rise close to the two-hundred-foot contour, with evident headward cutting in some cases. Now the upper marine limit for this part of the coast is also considered to lie close to this contour. The writer considers these streams to be *consequent* streams developed during the uplift of the land after the last ice-sheet and ocean withdrew from this region.

When the ice withdrew, the land must have risen faster than sea-level, because the sea-level was also rising, due to deglaciation. When the water stood at the upper marine limit the last ice was withdrawing and the sea washed against the ice-front, as proved by Keith and Katz and others. Antevs says: "If, as is probable, the ocean at the uncovering of the Maine coast (about 30,000 years ago) was lowered some two hundred feet, the land was lowered some two hundred feet plus the amount of the height of the marine limit above the present sea-level. Places with the marine limit at two hundred and fifty feet altitude, for instance, were lowered four hundred and fifty feet and have later risen this amount."[1] It must have taken a long time for the land and ocean to attain their present relations. The consequent streams started their careers as soon as the strand line began to move downward, those streams near the upper marine limit starting first and other streams nearer the sea starting later. The cutting of the gorge of the Merriland River did not begin until late, as it is only about one hundred feet above the tide to-day at the upper part of the gorge.

Considering the fact that cutting goes on mainly during the springs of each year and in times of heavy rainfall, 30,000 years does not seem too long a time to accomplish the results observed. It is enough to say that the time since the upper marine limit, development of consequent streams and the cutting of the gorge of the Merriland River is a very long time, and may be greater than 30,000 years.

The writer believes that such consequent streams may be used to check approximately the upper marine limit, and as a means of testing the determinations of the upper marine limit already made. The word "approximate" is used because headward cutting varies on each of the streams so they can not be used as definitely as beaches, for instance, in such determinations.

It is also possible that where the field evidence of the upper marine limit and the sources of the consequent streams do not coincide, these consequent streams might be used to determine the differential coastal movements that have taken place since the Pleistocene period.

ROBERT W. SAYLES

HARVARD UNIVERSITY

[1] *Am. Jour. of Science*, 15: 328, April, 1928.

REPORTS

PILOT FITNESS AND AIRPLANE CRASHES[1]

IN the early days of aviation, particularly during the world war, the need for testing the fitness of pilots for flying was duly recognized. In later years, however, the importance of testing pilot fitness was overshadowed by the development of instruments and the stress laid on them as a guide for flying. In this a

[1] From the Research Laboratory of Physiological Optics, Baltimore, Md.

grave mistake may have been made. Recently there seems to be a growing conviction that the pilot is an important factor in the increasing number of airplane crashes.[2] There is perhaps a good reason for this conviction. It may be that with the rapid improvement in the facilities for aviation, the attitude of the pilot has changed with respect to the importance of his own qualifications, fitness and training and to the highly specialized nature of the services he was formerly called on to contribute and still has to contribute in emergencies. It may be also that not enough attention is paid to fitness in the selection of pilots and to making sure that they are in fit condition for service at all times when they are called on to render service. It seems strange that the plane should be carefully tested on every point of its construction and operation before each flight and little or no attention given to the pilot at that important time other than to see that he is on hand to fly. With the advance in scientific and mechanized control, the importance of the human factor has without question been thrust into the background.

During the world war we devised an instrument for testing the fitness of aviators. This instrument was used at Mineola for testing and studying the fitness of entrance candidates and later was taken to France by Dr. William Holland Wilmer, surgeon in charge of the Medical Research Laboratories, Air Service, A. E. F., for the purpose of studying the fitness of aviators already in the service for the various tasks required of them, particularly in combat flying. Since the war the instrument has been greatly improved and is now being manufactured by the Gaertner Scientific Corporation. As manufactured by this company the instrument has been still further improved. One of the earlier improved models was described in the *Archives of Ophthalmology*.[3] In 1933–36 this model of this instrument was used by Lieutenant-Commander C. J. Robertson, of the United States Naval Service, for the study of fitness for aviation on such points as entrance requirements, disqualification for the service on account of age, fatigue in relation to number of hours in the air, individual susceptibility to fatigue, etc. Dr. Robertson has published his results in a series of articles in the *U. S. Naval Medical Bulletin* and the *Archives of Ophthalmology*.[4]

With this instrument can be measured among other things the speed of change of adjustment of the eyes for clear seeing at near to clear seeing at far and back again to near. This involves a measurement of the speed of vision, the speed of use of the muscles of the eyes in the perfect coordination needed for the clear seeing of a small detail and the speed of accommodation. It constitutes an extremely sensitive test of the ocular and oculomotor fitness of the aviator and of small disturbances in this fitness; also a very delicate and effective test for bodily and mental fatigue and other disturbances in physical and mental facility and proficiency. Fatigue, for example, has to be tested through its effect on some function. Perhaps no more delicate means can be found for detecting fatigue than through its effect on speed in those uses of the eyes which require highly coördinated changes in muscular adjustment. The delicacy and accuracy of coordination that are required in these adjustments will be realized when one remembers that changes in the convergence of the eyes are made by six pairs of muscles which serve to support as well as to move the eyes and that the breadth of the images on the two retinas which must be combined into one in seeing is, for the standard test object, of the order of thousandths of a millimeter. Also in changing the vision from near to far and back again to near, the muscles of accommodation must act in perfect coordination with the muscles that move the eyes. Still further, the sensorium must function at a high level of efficiency.

The test is without doubt one of the most sensitive that has ever been devised for the detection of any imperfection in the oculomotor, accommodative or sensory functions or any temporal disturbance in these functions. It is with these temporal disturbances that we are particularly concerned in this paper. Common causes of these disturbances are fatigue, loss of sleep, worry and all mental states which distract attention, the variations in physical and mental efficiency and alertness common to every one in the course of time, illness, etc. Any of these may be sufficient to cause the aviator to fail or falter at a critical time in the high degree of service that is required of him. The profound effect of fatigue and other disturbances of bodily and mental efficiency on such highly organized and delicate muscular coordinations as are required in

[2] Major-General James E. Fechet (Ret.), formerly chief of the U. S. Air Corps, for example, who has devoted a great deal of time to the study of airplane crashes, states (*Flight Surgeon Topics*, School of Aviation Medicine, Randolph Field, Texas, 1937, Vol. 1, No. 2, p. 44) that in more than half the number of cases these crashes are due to personnel error or to undetermined causes. In the personnel group he includes the following: the pilot, the weather man, the airline operations manager and the mechanic. Of these the pilot is of course a very important factor. A small per cent. of these crashes—less than five, he says—is due to mechanical failure—engine malfunctions, breakage of some part of the plane or its essential accessories. A considerably higher per cent. is due to bad weather—ice, fog or storm.

[3] C. E. Ferree and G. Rand, *Arch. Ophth.*, 15: 1072–1087, 1936.

[4] C. J. Robertson, *U. S. Naval Medical Bulletin*, 32: 275–283, 1934; *ibid.*, 33: 187–205, 1935; *Arch. Ophth.*, 14: 82–89, 1935; *ibid.*, 15: 423–434, 1936; *ibid.*, 17: 859–876, 1937.

the speedy use of the eyes is too well recognized to need further mention here.

It seems strange, indeed, that so much care is taken to see that the plane is in perfect condition before a flight is undertaken and so little attention given to the condition of the aviator. While it is true that a human being can not be treated as a machine, we do know, as noted above, that he is subject to many disturbances from day to day that render him unfit for those services which require a supernormal fitness and proficiency and involve a responsibility for human life and safety. It seems only reasonable, therefore, that the fitness of the aviator should be tested before each flight is undertaken as well as the fitness of the plane which he operates. It is surely not enough to require only an entrance test of fitness and then allow him to go on without further check, even without regulation of his conditions of living, until age or some mishap retires him from service.[5]

Our personal feeling is that a test should be made of each aviator immediately before and after each flight. We have the following reasons to offer for this:

(1) The test before the flight should be used to prevent the aviator from going into the air when he is clearly and dangerously unfit for service. It is neither fair nor good public policy that a knowledge of his fitness should depend upon his own report. In combat flying in particular he might well be prevented from making such a report through fear of being called a slacker or because of patriotism or personal pride. In commercial service, too, many reasons might operate to deter him from making a report of unfitness. The responsibility for making such report should be taken out of his hands and consigned to a competent examiner. A surgeon, however long his experience and however well demonstrated his ability, voluntarily subjects himself to a test of steadiness of hand and keenness of eye before undertaking a critical operation. Surely in these offices requiring services equally responsible for life and safety, there should be some test of fitness immediately before the service is undertaken.

[5] We understand that some improvement in this respect has already been made or is in contemplation. The following, for example, is quoted from the article by Major-General Fechet referred to earlier in the paper: "Striving to promote continued pilot fitness, we developed a new profession in the Army—that of Flight Surgeon. He has paid us handsome dividends. We found that annual or semi-annual examinations were not enough. We needed a smart medico to keep the pilots under daily observation. ... Flight Surgeons paid off in reducing airplane crashes. I commend that thought to commercial airline operators." He says further: "Health is mental as well as physical. I think the mental side plays a bigger rôle in air pilot health than the physical. A man who is worried and preoccupied about domestic discord or financial extremities may be more unsafe than one subject to fits or fainting spells."

Such precautions might be considered extreme had it not been so clearly demonstrated that something is radically wrong in modern aviation.

(2) The test at the end of the flight would indicate how well the aviator has stood the strain of his service. It would give valuable information as to his susceptibility to fatigue and make it possible to assign him to the length and kind of service he is capable of performing. It would also give a great deal of valuable general information as to the number of hours in the air and the amount of strain which aviators, taken collectively, can reasonably be expected to stand.

(3) From the results of the tests, graphs or curves can be plotted which will give a splendid picture of the aviator's fitness, his endurance, his susceptibility to fatigue, the consistency of his service, etc. In short, these records would serve as the basis for a high type of personnel service in aviation. From these graphs it can also be readily seen when the aviator is becoming incapacitated for service through age or some other cause. This alone should be a sufficient reason for adopting some such program.

(4) A feasible test and instrument are available. The test does not require more than ten minutes to perform and the result can readily be given a numerical rating. The instrument is easy and convenient to operate and the entire program well within the technical capabilities of the average flight surgeon.

Two forms of the test may be suggested: (1) The time required for the discrimination of the object at near, the change to far and back again to near may be measured in each test; or (2) in a series of preliminary tests the median or average times required for these performances may be determined for each aviator and these be taken as his standard of performance. In the routine procedure of testing, the instrument should be set to give these times of exposure. The test may consist of ten or some suitable number of trials to ascertain in what percentage of cases the aviator can attain his standard of performance. This percentage may be accepted as the index of his fitness at that time.

The instrument recommended may be called a multiple-exposure tachistoscope. As described in the *Archives of Ophthalmology*,[3] it comprises a driving mechanism, four sectored disks so arranged and of such sizes as to expose in immediate succession, in turning, a near test object on the left, a far test object in the median plane and a near test object on the right. The test objects are the letter E, the openings of which can be turned in eight different directions to give an objective check on the judgment. The far test object is provided with a remote control such that these adjustments can be made by pressing an electric key at the position of the examiner. The distance of the far test surface and the lateral separation of the

two near test surfaces can be varied at will. The sectored disks are turned by means of a constant-speed motor provided with gears to give suitable reductions in speed, and an intermittent gear which causes the disk covering the test objects prior to the beginning of the exposure to stop in exactly the same position at the end of a single rotation. In the preferred form the values of open sector are adjusted by small worm-gears which serve both to change the position of the movable disks and to hold them firmly in position for any given setting. Exposure may be made in continuous series up to four seconds. Both the angular values of open sector and the times of exposure can be read from suitably positioned, graduated scales.

A later form of the instrument is an electrical tachistoscope. This is the form now being made by the Gaertner Scientific Corporation. In Fig. 1 are

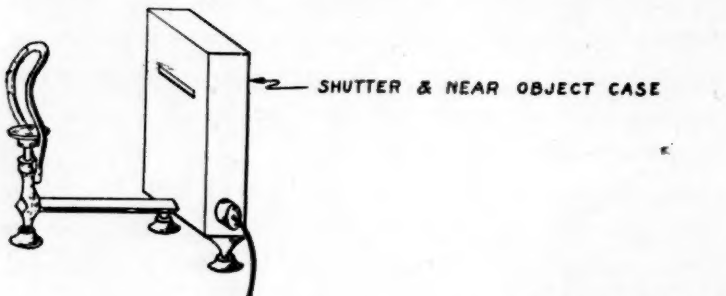


FIG. 1. An electrical, multiple-exposure tachistoscope.

shown the control panel and the case containing the near objects, the means for illuminating these test objects and the shutters for exposing both the near and the far test objects. The shutters are operated electromagnetically and are so arranged as to expose in sequence the test objects in the order noted above, namely, the near test object on the left, the far test object in the median plane and the near test object on the right. In the control panel are housed relay devices for operating the shutters and adjusting the position of the far object. On the outside of the panel suitable buttons and switches are provided for these controls and a dial or time interval scale with hands that can be set to give the values of exposure desired. This form of the instrument has been designed especially to give compactness of construction and the maximum convenience of operation.

Either of the above forms of the instrument makes possible the following determinations: (a) The use of a set of very sensitive tests which take into account as no other tests do both the motor and the sensory functions of the eyes in just the proportion that they occur in the act of seeing objects in different directions and at different distances. (b) The testing of the dynamic speed of vision with either the oculomotor or the accommodative feature emphasized. In the dynamic test for speed of vision the eyes are required to shift their regard from one object to another or to a series of objects and to discriminate them in turn during the time or times of exposure. These conditions test not only the speed of reaction of the sensorium but also the oculomotor facility and proficiency. And (c) the measurement of the time required to change from near to far and from far to near in combination or separately.

The instrument and test have the following practical uses: (a) A means of detecting abnormalities and depressions in the oculomotor functions in the work of the clinic; (b) a test for vocational fitness in all cases in which dynamic speed of vision is an important requirement; (c) a limiting test for age; (d) a means of measuring ocular and oculomotor fatigue and recovery and of testing individual susceptibility to ocular fatigue and the capacity to recover. Because of the profound effect of fatigue and other disturbances of bodily and mental efficiency on such highly organized and delicate muscular coordinations as are required in the speedy use of the eyes, the test may be used also as a very sensitive means of detecting bodily and mental fatigue and other disturbances in physical and mental proficiency which occur so frequently in the normal course of living. It may be used also for detecting and studying the effect of altitude, temperature and other variations in the physical conditions to which the aviator is subjected. And (e) a means of training the eyes to greater oculomotor and accommodative efficiency.

SUMMARY

With the growing conviction that the pilot is an important factor in the increasing number of airplane crashes, it seems that more attention should be paid to fitness in the selection of pilots and to making sure that they are fit for service at all times when they are called upon to render service. It is strange indeed that so much care is taken to see that the plane is in perfect condition before a flight is undertaken and so little attention is given to the condition of the pilot. While it is true that a human being can not be treated as a machine, we do know that he is subject to many disturbances from day to day that render him unfit for those services which require a supernormal fitness and proficiency and involve a responsibility for human life and safety. These disturbances can be shown by test.

In the paper a very sensitive test for these disturb-

ees in fitness is proposed and a convenient instru-nt for giving the test is briefly described. The test lls well within the technical capabilities of the aver-e flight surgeon and should not require more than minutes to perform. It is recommended that the t should be given both immediately before and mediately after each flight. Reasons for this are:) The test before the flight can be used to prevent e aviator from going into the air when he is clearly d dangerously unfit for service. It is neither fair r good public policy that a knowledge of his fitness ould depend upon his own report. The responsibil- for making such report should be taken out of his nds and consigned to a competent examiner. (2) e test at the end of the flight would indicate how ll the aviator has stood the strain of his service. It would give valuable information as to his susceptibility to fatigue and make it possible to assign him to the length and kind of service he is capable of performing. It would also give a great deal of valuable general information as to the number of hours in the air and the amount of strain which aviators, taken collectively, can reasonably be expected to stand. (3) From the results of the tests, graphs or curves can be plotted which will give a splendid picture of the aviator's fitness, his endurance, his susceptibility to fatigue, the consistency of his service, etc. From these graphs it can also be readily seen when the aviator is becoming incapacitated for service through age or some other cause.

C. E. Ferree
G. Rand

SPECIAL ARTICLES

VISUAL PURPLE AND ROD VISION[1]

So much evidence has accumulated to show an ap-oximate agreement between the absorption spectrum visual purple and the spectral sensitivity at low ensity (rod vision) in the mammal that there can be tle doubt that this substance is the light absorber r the process. Hecht and Williams[2] (1922) com-red their data for the human retina with the average lues for mammalian visual purple obtained by Kött-n and Abelsdorff,[3] and pointed out that the spectral nsitivity curve was uniformly displaced about 7 mμ ward the red from the absorption spectrum. This y accounted for on the basis of Kundt's rule, which tes that the greater the refractive index of the lvent, the farther is the absorption spectrum shifted ward the red. They assumed that the solvent medium the rods is of a higher refractive index than the ueous solution in which the absorption spectrum of e visual purple was measured. Actually Kundt's le has so many exceptions that it can hardly be garded as a rule at all, so that this explanation is of tle value, and it is the purpose of the present com-nication to show that if the data are properly ex-essed they can be made to agree within the limits of perimental variation so that there is no need of uming a displacement toward the red nor invoking e questionable rule of Kundt.

It must be recalled in making such a comparison t while absorption spectra are always measured in ms of energies, the receptor actually responds to mber of quanta. The latter must be true if the receptor response is based on some sort of photochemical process, which seems certain. Thus it is necessary to convert absorbed energies into number of quanta before comparing them with the relative stimulating energies. There are numerous factors which may prevent an agreement between the absorption spectrum and the receptor sensitivity, but no correspondence is to be expected except on the above basis.

The conversion from energies into relative number of quanta is easily made, since the size of the quantum is related to the wave-length in the following manner: $\varepsilon = hc/\lambda$, where ε is the quantum, h Planck's constant, c the velocity of light, and λ the wave-length. Since both h and c are constants, the quantum must be inversely proportional to λ. Thus the number of quanta in equal intensities of light of different wave-length is directly proportional to the wave-length, so that absorbed energies may be converted into relative number of quanta by merely multiplying by the wave-length. Since the wave-length range is not great in the present case, the correction can not be of great magnitude; in fact, Hecht[4] dismisses it in a recent review (1937) by the following statement: "Strictly, the assumption should be that a constant number of quanta is required, but because of the small range of wave-lengths the difference between the two is negligible." However, the accompanying curves will show that the correction is of just sufficient magnitude to take care completely of the discrepancy pointed out by Hecht and Williams (1922) and still explained by Hecht on the basis of Kundt's rule in 1937.

In Fig. 1 are plotted the data of Hecht and Williams for the sensitivity of the dark-adapted human eye at very low light intensity, together with the measurements of mammalian visual purple by Köttgen and

[1] The Division of Physiology, University of California dical School, Berkeley, Calif.

[2] S. Hecht and R. E. Williams, *Jour. Gen. Physiol.*, 5: 1922.

[3] E. Köttgen and G. Abelsdorff, *Ztschr. f. Psych. u. ysiol. d. Sinnesorgane*, 12: 161, 1896.

[4] S. Hecht, *Physiol. Rev.*, 17: 239, 1937.

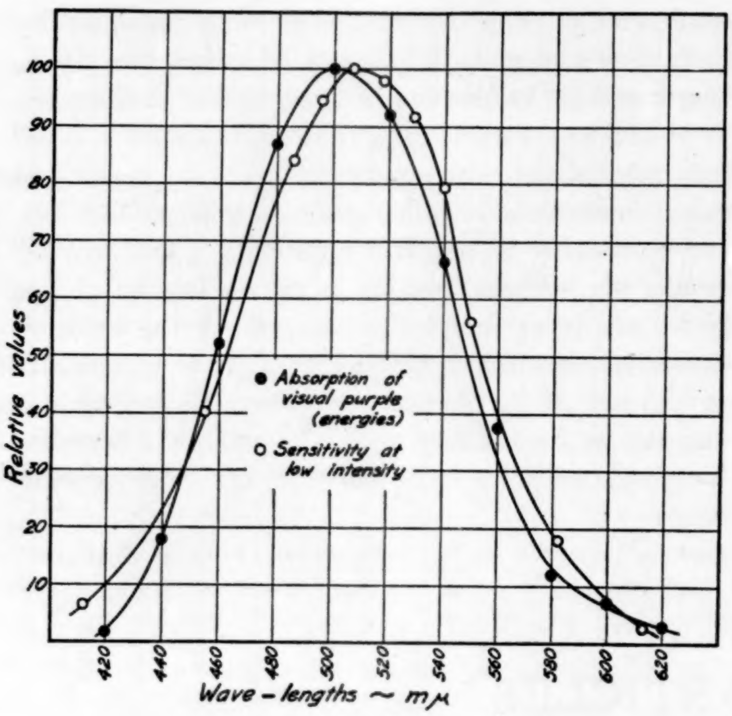


FIG. 1

Abelsdorff (1896). The data of Köttgen and Abelsdorff are for the monkey, the dog, the cat and the rabbit, all of which are in agreement. They are also in approximate agreement with rough measurements for a human eye made by Koenig, and it is reasonable to assume that the substance is identical in all mammals. The curves in Fig. 1 are essentially those plotted by Hecht and Williams except that I have included two values for absorption of visual purple at 420 mμ and 440 mμ, which Hecht and Williams discard. When these two points are included the shift toward the red is less evident. While there is a considerable variation in the values for these points it seems that they may be safely included in the data.

In Fig. 2, the absorption spectrum measurements

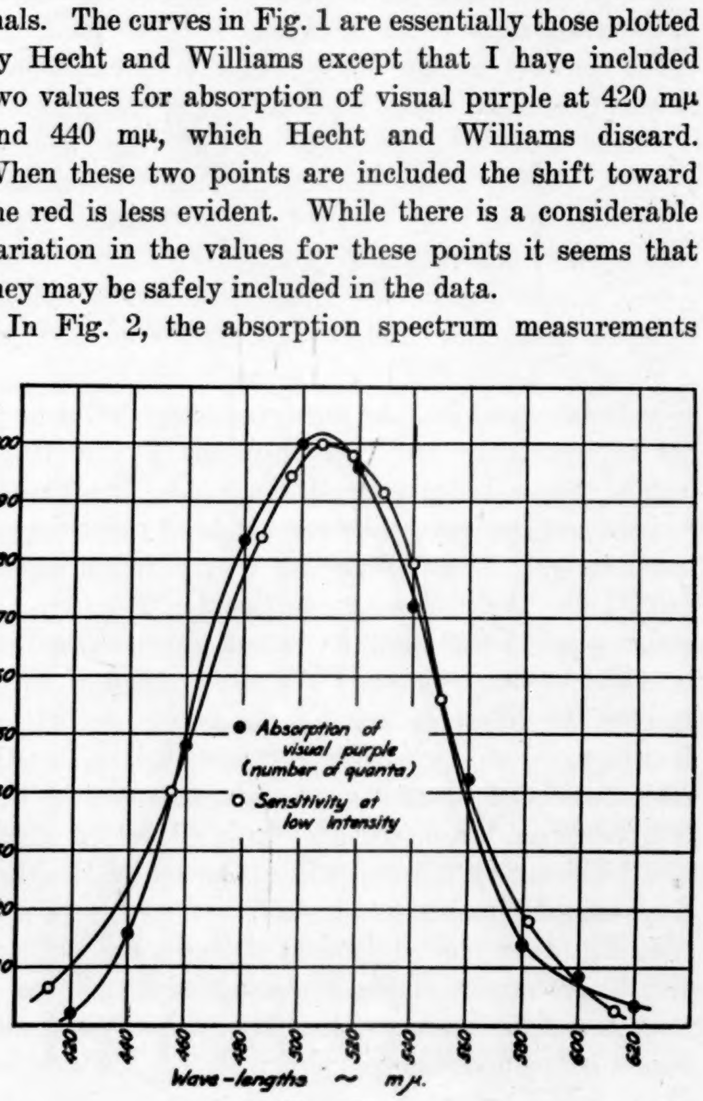


FIG. 2

are converted into relative number of quanta by [mul-]tiplying by the wave-length and then by a compar[ison] factor to bring the maximum value at 500 mμ [into] agreement with maximum sensitivity of the eye [at] 507 mμ. The two sets of data are now in rather [good] agreement, but a separate curve has been dr[awn] through each. The maximum of the absorption c[urve] as drawn is at the same wave-length as the maxi[mum] of sensitivity, but about 2 per cent. above. Co[nse]quently, the points have all been lowered 2 per c[ent.] in Fig. 3. In the latter figure are also included

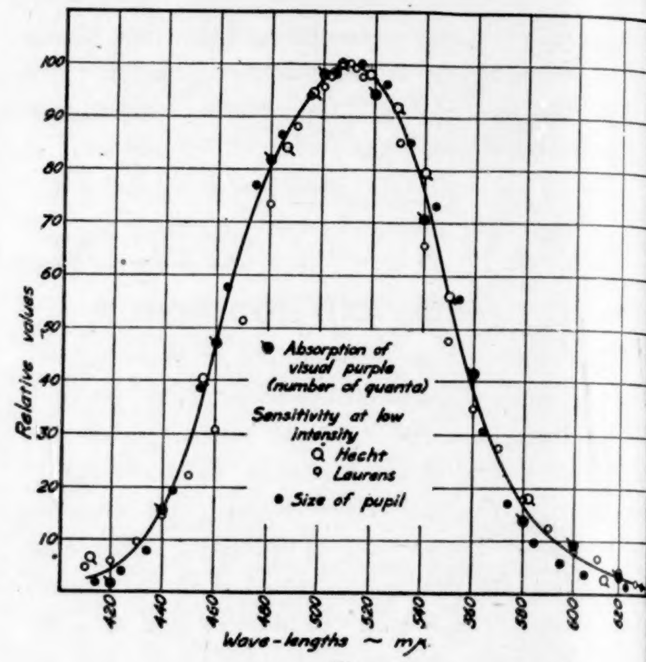


FIG. 3

data of Laurens[5] (1923) for pupil size as relate[d to] wave-length for the dark-adapted eye at low inten[sity] and also his measurements[6] (1924) of the spe[ctral] sensitivity of the human eye under similar conditi[ons.] The former, which constitute a purely objective [mea]surement of the spectral response of the retina, a[gree] very well with the recalculated absorption spect[rum] data, while the latter deviate somewhat from all [the] rest. With the exception of Laurens's spectral [sen]sitivity measurements which were obtained for [only] two subjects, the data are in very close agreem[ent.] The alleged displacement toward the red has [com]pletely disappeared, and there is no further need [for] Kundt's rule.

H. F. BLU[M]

UNIVERSITY OF CALIFORNIA

ON THE SPIROCHETICIDAL ACTION O[F] THE ARSPHENAMINES ON SPIROCHETA PALLIDA IN VITRO[1]

SOON after the discovery of arsphenamine, it [was] reported that the substance had no direct spiroc[heticidal]

[5] H. Laurens, *Am. Jour. Physiol.*, 64: 97, 1923.

[6] H. Laurens, *Am. Jour. Physiol.*, 67: 348, 1924.

[1] From the Syphilis Division of the Departmen[t of] Medicine, Johns Hopkins University Medical School, [Bal]timore, and the U. S. Public Health Service, Washin[gton]

action on *S. pallida in vitro.* This observation been generally accepted, and the mechanism eby the drug exerts its therapeutic action in ilis has been a problem of long standing. It is lly assumed that its therapeutic effect rests on its ersion *in vivo* to some other actively spirocheti- substance.

ntrary to this general impression, we have found arsphenamine, neoarsphenamine, silver arsphen- e and "arsenoxide" (metaminoparhydrooxyphen- enoxide) effect a complete immobilization *in vitro* rulent *S. pallida* (Nichols strain) obtained from t testicular chancres. Moreover, these immobil- organisms are non-infectious for rabbits, as n both by testicular inoculation and by subse- t lymph node transfer, and are presumably dead. e rate at which this antispirochetal action pro- , and the minimal effective concentration of the ical, depend on numerous variables. Thus, there arge positive temperature coefficient in the range to 37° C. Serum, tissue particles and, in par- ar, a tissue mash, all *inhibit* the antispirochetal , perhaps because they combine with the arsphen- es. The degree of aerobiasis seems to have but effect.

der appropriate experimental conditions, arsphen- e and neoarsphenamine have a definite spirocheti- effect *in vitro* within eight hours in at least 0,000 dilution; and "arsenoxide" immobilizes the nisms in dilutions of at least one million. It is terest that these concentrations are of the same of magnitude as those attained *in vivo* after the peutic administration of these drugs.

periments are now in progress to ascertain to extent oxidation products of the arsphenamines, ed under the conditions of the experiment, con- te to their antispirochetal action. It is further us that *in vitro* results have no necessary impli- n with respect to the therapeutic action of the henamines *in vivo.* Nevertheless, the current con- that the arsphenamines are converted only *in vivo* directly spirocheticidal agent is based on their osed inactivity when added to the organisms *in* . Since that initial premise is apparently in error, comes advisable to reinvestigate the possibility, that the therapeutic action of the arsphenamines rest in part on a spirocheticidal effect similar to observed *in vitro,* and second, that this spiro- cidal action may be an intrinsic property of the henamines *per se,* rather than of degradation ucts liberated *in vitro* or *in vivo.* Although the henamines are undoubtedly converted to other ances *in vivo* in the course of their elimination, conversion may perhaps not be an essential pre- ary to their therapeutic action.

Several other implications of possible practical importance may be pointed out. As will be described in a following paper, the immobilizing activity of a given arsenical can be assayed by a simple *in vitro* experiment. It becomes of interest to ascertain the degree of correlation between antispirochetal activity as determined by this *in vitro* test, and therapeutic activity as determined in infected rabbits. Finally, the *in vitro* technique should facilitate the study of the chemical nature of the reaction between arsphenamines and spirochetes, and the development of new therapeutic agents with more favorable therapeutic: toxic ratios. Work along these several lines of investigation is now in progress.

HARRY EAGLE
WILLIAM MENDELSOHN

A RELATION BETWEEN THE AVERAGE MASS OF THE FIXED STARS AND THE COSMIC CONSTANTS

THE physics of the universe is essentially characterized by the three following relations which are fulfilled as to the order of magnitude:[1]

$$(1)\quad N = (R/a)^2$$
$$(2)\quad T = 1/u$$
$$(3)\quad R/a = e^2/(f\, m_p\, m)$$

R and T being the radius and the age of the universe, N the total number of protons and neutrons, u Hubble's constant (500 km/sec. per mega-parsec. $= 1.6 \times 10^{-17}$ sec.$^{-1}$), f Newton's gravitational constant, e the fundamental charge, m_p and m the masses of the proton and the electron, respectively, and a the classical radius of the electron ($e^2/(mc^2)$).

A further relation might be added to the above three connecting M, the average mass of a fixed star, with the cosmical constants. It has the simple form

$$(4)\quad f\, M^2 = N\, e^2.$$

If we assume that equations (3) and (4) are fulfilled not only as to the order of magnitude, but exactly,[2] we arrive at a remarkable result. Dividing equation (4) by equation (1) written in the form

$$R^2 = N\, a^2,$$

we find

$$(5)\quad (f\, M^2)/R^2 = e^2/a^2.$$

According to this formula the gravitational force which two fixed stars of average mass exert upon each other, at a distance equal to the radius of the universe, is as large as the electrostatic force acting between two fundamental charges at a distance equal to the classical radius of the electron.

[1] *Cf.* P. Jordan, *Naturwiss.,* 25: 513, 1937; A. Haas, *Naturwiss.,* 25: 733, 1937.

[2] *Cf. Physical Review,* 53: 207, 1938, Abstract of the Chicago meeting of the American Physical Society, No. 25.

If in equation (4) we insert that value for N which results from a combination of equations (1) and (3), that is

$$(6)\quad N = e^4/(f^2 m_p^2 m^2)$$

we find

$$(7)\quad M = e^3/(f^{3/2} m_p m).$$

By inserting on the right-hand side of (7) the well-known values for the constants, we obtain

$$(8)\quad M = 4 \times 10^{33} \text{ grams}$$

or about twice the mass of the sun. This result is in good agreement with astronomical observations, since the fixed stars were found to have masses varying between about 0.2 and 50 times the mass of the sun, the average mass being a modest multiple of that of the sun.

ARTHUR E. HAAS
UNIVERSITY OF NOTRE DAME

AN APPROACH TO THE SYNTHESIS OF FICHTELITE

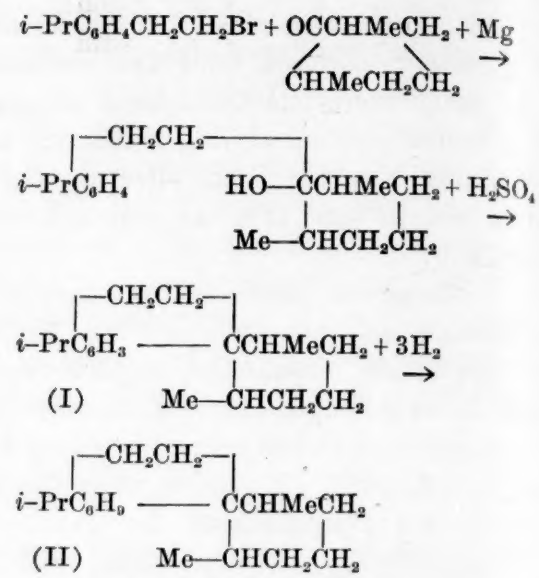
ONE of the most interesting of the retene derivatives is the fichtelite which occurs, usually associated with retene itself, in partially fossilized pine trunks found in various European peat and lignite beds. Its source is evidently the resin acids originally present in the coniferous woods in which it lies buried. It has been known for just about a century. For many years it was believed to be perhydroretene, $C_{18}H_{32}$, until Ipatiew's synthesis of the latter proved that the two were not identical. Based upon some new experimental work, Ruzicka and Waldmann recently[1] proposed for fichtelite the structure of 12-methyl-perhydroretene, or perhydroabietane, $C_{19}H_{34}$ (II).

In the January, 1938, issue of the *Journal* of the American Chemical Society, Fieser and Campbell (p. 167) have described a tetrahydroabietic acid (m.p. 163–164.5°), decarboxylation of which should yield 12-methyl-perhydroretene.

Since in these laboratories we have for some time been attacking, from the synthetic side, this problem of the constitution of fichtelite, it seems to us desirable to report here briefly the progress to date.

Steps followed in this synthesis have been the following, using *m*-bromocumene as the initial material:

$$m\text{-}i\text{-PrC}_6\text{H}_4\text{Br} \xrightarrow[+\,\text{Mg}]{+\,(\text{CH}_2)_2\text{O}} i\text{-PrC}_6\text{H}_4\text{CH}_2\text{CH}_2\text{OH} \xrightarrow{+\,\text{PBr}_3}$$



The octahydro derivative (I) gave retene when fus[ed] with selenium. Catalytically hydrogenated at 22[…] and 150 atmospheres pressure, for four hours, in t[he] presence of Raney nickel, in methylcyclohexane so[lu]tion, it absorbed 3 moles of hydrogen per mole [of] hydrocarbon, with formation of a $C_{19}H_{34}$ hydrocarb[on] as an odorless, colorless, transparent, viscous oil, b[.p.] 179–181° at 12 mm., n_{25}^{D} 1.5025, which congealed to [a] glassy solid when cooled well below laboratory te[m]perature. With cold alkaline permanganate or wi[th] a carbon tetrachloride solution of bromine, it behav[ed] as a saturated compound and also was inert to co[n]centrated sulfuric acid.

As fichtelite is a white crystalline solid, m.p. 4[…] our synthetic product obviously is not identical the[re]with. It may be that the difference between the t[wo] is a stereochemical one[2] or that our product requi[res] further purification.

A critical comparison of the synthetic with the na[t]ural product has been delayed by the difficulty we ha[ve] encountered in securing an adequate supply of fic[h]telite.

The research is being continued, in the endeavor [to] clear up these points.

To Professor Homer Adkins, of the University [of] Wisconsin, we are particularly indebted for his as[sis]tance in the catalytic hydrogenation of the octahyd[ro] derivative (I).

MARSTON TAYLOR BOGE[RT]
EDWARD C. STERLING
ORGANIC CHEMISTRY LABORATORIES,
COLUMBIA UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A BATH FOR SMOOTH MUSCLE

IT is difficult when recording smooth muscle contractions *in vitro* to change the fluid surrounding the muscle without exposure of the preparation to t[he] atmosphere. This may be accomplished rapidly a[nd] easily with the smooth muscle bath shown in the f[…]

[1] *Helv. Chim. Acta*, 18: 611, 1935.

[2] *Cf.* Ruzicka, Balaš and Schinz; *Helv. Chim. Acta*[…] 695, 1923.

companying diagram. The chamber is 3.5 cm in diameter and 14 cm long. The stopcock B is very carefully ground so that it is tight without grease but does not bind. To prevent any possibility of the water in the constant temperature tank contaminating the fluid in the bath the whole stopcock is surrounded by a glass jacket. After warming to the required temperature by passage through a glass coil immersed in the tank, the bath fluid is saturated with O_2–CO_2 mixture. This is done in a 2L Erlenmeyer also immersed in the constant temperature tank and provided with a release valve. The pressure is utilized to force the fluid from the

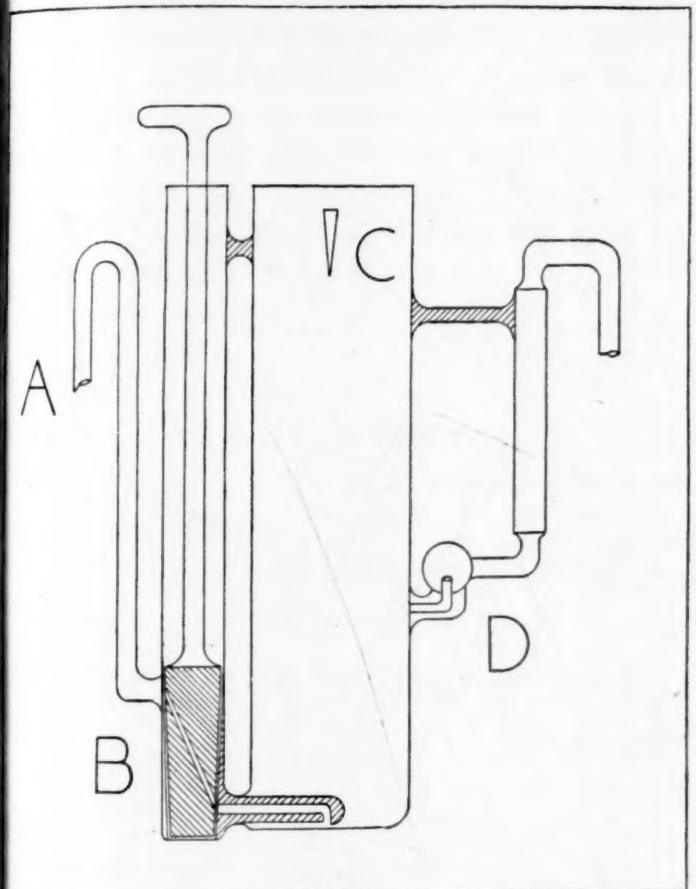


Fig. 1

Erlenmeyer into the bath through the tube A when the stopcock B is open. Fluid is allowed to flow until it reaches the glass level-marker C. When it is required to change the fluid the stopcock B is opened and more fluid allowed to flow until the syphon D operates. It will be seen that the flow through the syphon will cease before the muscle, which is suspended as low as possible in the chamber, is exposed. Because of the arrangement of the tube in the bottom of the chamber through which the fluid enters, complete displacement of the original fluid may be accomplished in two washings. This was ascertained by tests with dyes. The flow of fluid from the tube does not interfere in the least with the normal contractions of the muscle and it is impossible to tell by inspection of the kymographic record when the fluid is changed. Continuous aeration of the bath fluid may be performed, should it be desired, by allowing the level of the fluid in the Erlenmeyer to fall below the delivery tube, when the gas mixture may be passed directly through the tube A and regulated by stopcock B.

A. R. McIntyre
F. F. Anderson

Department of Physiology and Pharmacology
University of Nebraska

THE MEASUREMENT OF pH IN CIRCULATING BLOOD[1]

Continuous records of changes in blood acidity were obtained with a MnO_2 electrode by Gesell and Hertzman in 1926.[2] The technique was improved by Voegtlin, De Eds and Kahler,[3] who replaced the MnO_2 electrode with a glass electrode and succeeded in more accurately estimating the pH of circulating blood. They demonstrated convincingly at that time, and again more recently,[4] the suitability of the glass electrode for pH studies in living systems.

The microvoltmeter of Burr, Lane and Nims,[5] with slight modifications, is an ideal instrument for the measurement of glass electrode potentials, not only because of its high sensitivity, but also because of its inherent stability which makes possible continuous recording over long periods of time. This has been demonstrated by Dusser de Barenne, McCulloch and Nims[6] in a study of functional activity and pH of the cerebral cortex.

In the present experiments, the pH of circulating blood was determined by means of a glass electrode, a microvoltmeter, a Leeds and Northrup potentiometer and a General Electric photoelectric recording galvanometer. Skin and other extraneous DC potentials were eliminated by placing a normal saline salt-bridge close to the glass electrode, both electrodes being in contact with the circulating blood.

This technique makes it possible to obtain, with a high degree of accuracy, the differential changes in the pH of the blood, as the conditions of the experiment are varied. Also the time relationships of such changes can be precisely determined, whether they be hours or seconds. Fig. 1 is a record of a single experiment,

1 From the Laboratories of Physiology and Neuro-Anatomy, Yale University School of Medicine.

2 R. Gesell and A. B. Hertzman, *Am. Jour. Physiol.*, 78: 206, 1926.

3 C. Voegtlin, F. De Eds and H. Kahler, U. S. Pub. Health Reports, 45: 2223, 1930.

4 C. Voegtlin, H. Kahler and R. H. Fitch, *U. S. Nat. Inst. of Health Bulletin*, No. 164; 15, 1935.

5 H. S. Burr, C. T. Lane and L. F. Nims, *Yale Jour. Biol. and Med.*, 9: 65, 1936.

6 J. G. Dusser de Barenne, W. S. McCulloch and L. F. Nims, *Jour. Cell. and Comp. Physiol.*, 10: 277, 1937.

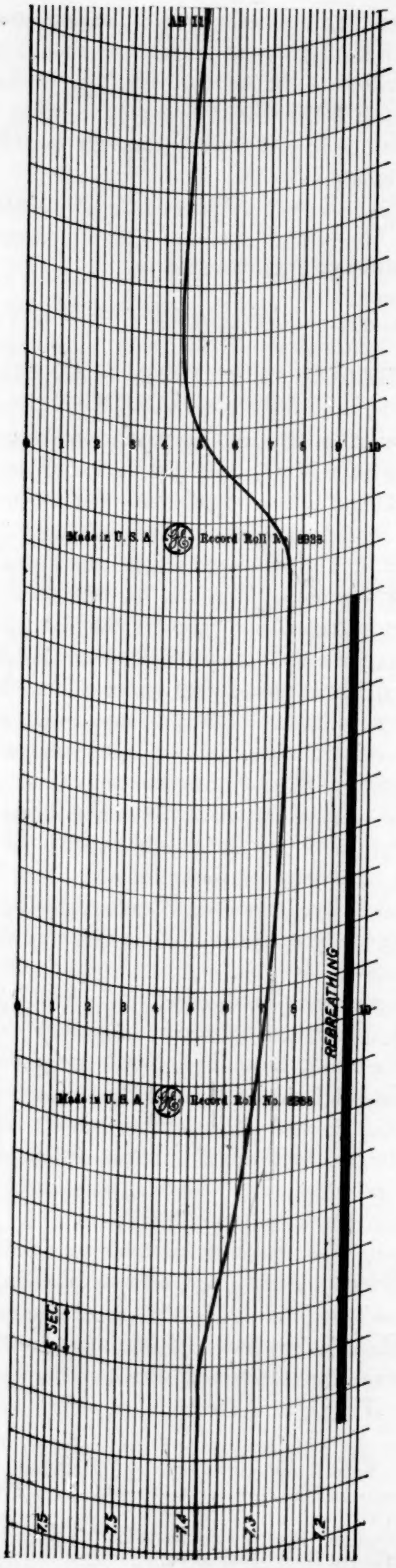


FIG. 1. The pH of circulating blood during a short period of rebreathing. Dog, male, 10 Kg. Na Amytal anesthesia, Heparin intravenously. Animal made to rebreathe by placing a surgical rubber glove over the snout. Time divisions, 5 sec.; pH units at left.

illustrating the type of information obtainable. In this experiment the electrode system was placed in the femoral artery of a heparinized dog, under sodium amytal anesthesia, and the animal was made to rebreathe its expired air for a period of 88 seconds, as indicated by the solid black line in the figure. Within 8 seconds after rebreathing was initiated, the blood began to shift to the more acid side; in 40 seconds this change amounted to 0.08 pH unit; in the remaining period, the change was 0.03 pH unit more. Five seconds after cessation of the rebreathing, the blood became with surprising rapidity less acid, passing through its original level in less than 15 seconds after the reversal began. Its new level was not attained directly, but by a process of "over-shooting" and subsequent return from a slightly higher pH. The return to a stable condition required a minute or more.

Complete details of this technique, as well as the results of other experiments on the relationship of blood pH and respiration, will be published later.

LESLIE F. NIMS
CLYDE MARSHALL
HAROLD S. BURR

BOOKS RECEIVED

BRAMWELL, JAMES. *Lost Atlantis.* Pp. 288. Harper. $2.75.

BRUNER, HENRY L. *Laboratory Directions in College Zoology.* Revised edition. Pp. xiv + 163. Macmillan. $1.75.

COURANT, R. and D. HILBERT. *Methoden der Mathematischen Physik II.* Pp. xvi + 549. Die Grundlehren der Mathematischen Wissenschaften in Einzeldarstellungen. Band XLVIII. Julius Springer, Berlin.

Cours de Chimie Industrielle, Tome V. G. Dupont. Pp. 279. 18 figures. Gauthier-Villars, Paris. 70 fr.

Figures de Savants, Tome III. L'Académie des Sciences et L'étude de la France D'Outre-Mer de la Fin Du XVIIe Siècle Au Début Du XIXe. Pp. xiii + 220. 125 fr. Tome IV. Pp. 259. Illustrated. 150 fr. Gauthier-Villars, Paris.

GWYNNE-VAUGHAN, H. C. I. and B. BARNES. *The Structure and Development of the Fungi.* Second edition. Pp. xvi + 449. 309 figures. Cambridge University Press, Macmillan. $5.50.

HAMBLY, WILFRID D. *Source Book for African Anthropology. Volume XXVI. Part I, Publication 394. Section I, Outlines of Africa.* Pp. 404. 75 figures. *Part II, Section III, Basic Elements of Negro Culture.* Pp. 407–953. 76 figures. Field Museum of Natural History, Chicago.

NEWCOMBE, CURTIS L. *Laboratory Directions for an Elementary Course in General Zoology.* Pp. 104. 2 figures. The Weant Press, Baltimore.

OLMSTEAD, J. M. D. *Claude Bernard, Physiologist.* Pp. xvi + 255. Illustrated. Harper. $4.00.

Studies of the Institutum Divi Thomae. Vol. I, No. 2, November, 1937. Pp. v + 137 + 251. Illustrated. The Athenaeum of Ohio, Cincinnati. $0.50.

Symposium on Hormones. Sigma Xi Lectures for 1936–37, Ohio State University. Pp. 315–463. Illustrated. Reprinted from the Ohio Journal of Science.

Texas Agricultural Experiment Station. *Valuable Plants Native to Texas.* Bulletin No. 551, August, 1937. Pp. 173. Agricultural and Mechanical College of Texas.